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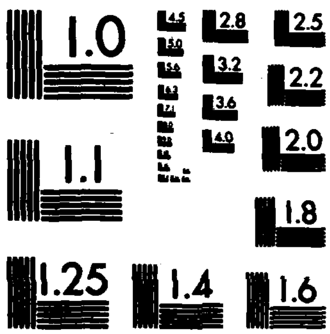
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TDI-TR-83-5

DISTRIBUTED INSTRUCTIONAL SYSTEM PROJECT

FINAL REPORT

PREPARED BY: A. S. GIBBONS

V. LINES

R. CAVAGNOL

WICAT SYSTEMS, INC.

27 APRIL 1983

PREPARED FOR:

US ARMY TRAINING AND DOCTRINE COMMAND
FORT MONROE, VIRGINIA 23651

US ARMY AIR DEFENSE ARTILLERY SCHOOL
FORT BLISS, TEXAS 79916

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FRANK E. GIUNTI
Chief, Instructional
Development Division

EDMUND J. GLABUS
Colonel, Infantry
Director, Training Developments
Institute

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The goal of this project was the development of a low cost computer controlled interactive delivery system capable of providing computer assisted instruction and 2D simulation.

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FINAL REPORT

A. S. Gibbons
V. Lines
R. Cavagnol

Contract No. DABT60-81-C-0007
U.S. ARMY TRAINING DEVELOPMENTS INSTITUTE
FORT MONROE, VIRGINIA 23651

BY
WICAT Systems, Inc.
P. O. Box 539
1875 South State Street
Orem, Utah 84057

EXECUTIVE SUMMARY

PURPOSE:

This report summarizes the results of the Distributed Instructional System (DIS) project. The project was carried out between January, 1981 and May, 1982 as a cooperative effort between the U.S. Army Training Developments Institute (TDI) of the Army Training and Doctrine Command (TRADOC), the Army Communicative Technology Office (ACTO) of the U.S. Army Communications Electronics Command (CECOM), the U.S. Army Air Defense School (USAADS) at Ft. Bliss, Texas, and WICAT Systems Incorporated of Orem, Utah.

The DIS consists of individual student workstations connected to a central storage station having main storage capability. Each workstation consists of a 16-bit WICAT microcomputer controlling a videodisc player. The system is operated through a specially designed hand-held keypad and can provide combination videodisc and computer-generated displays. The DIS system is designed to simultaneously deliver computer-assisted instruction (CAI) and 2-dimensional (2-D) simulation over a broad range of weapons systems and trained tasks to operator and maintenance personnel simultaneously.

The present project was the third and culminating phase of a system development effort funded by the Defense Advanced Research Projects Agency (DARPA) for the first two phases. Third phase funding was provided by TDI.

The goal of the three year effort was the development of a low-cost computer-controlled interactive videodisc delivery system capable of providing computer-assisted instruction and 2-D simulation. This report describes the system constructed to meet that goal, as well as the products created and validated in a demonstration of the instructional capabilities of the system. Section 2.0 provides a brief history of the system development effort and its goals. Section 3.0 describes the principles that guided system design and the designs which resulted. Section 4.0 presents the work plan, schedule, and organization created for development of the system, and Section 5.0 describes the results obtained. Section 6.0 gives a set of recommendations for further development of the concepts developed and implemented during this project.

The findings of the project were that 100% of the students using the DIS were capable of completing the performance test problems, whereas only 25% of the students not receiving the training were able to. Moreover, all students completing one or more simulation problems in addition to CAI lessons were able to complete the same test in half the time. Students reported enjoying the lessons and simulation problems and recommended its use at both school and field sites. Project results led to a set of recommendations for improvement and expansion of system training:

1. Expansion of simulation scope to include all I-HAWK Integrated Systems Checks.

2. Improvements in the equipment and software used in the delivery system.

3. Expansion of the DIS System evaluation to cover areas not approached by this evaluation.

4. An improved base of Instructional Systems Development (ISD) processes in the development of future products.

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Acknowledgements

The teamwork concept employed by the organizations taking part in this project cannot be overemphasized as a key factor in its success. Especially notable in this respect were the efforts of USAADS representatives Mr. Peter J. Baker and CW2 Donald Cooper, whose technical and liaison activities were indispensable at several points and whose dedication to the task was far beyond the usual effort. Also, Mr. Bryan Altman of TDI served a critial communication and coordination function which held the development team together during some of the more difficult decision-making processes.

Within WICAT, the efforts of several instructional development specialists, programmers and engineers were blended into the creation of lesson and simulation designs. In addition to the authors, the following persons were members of the HAWK design team:

Dr. A. F. O'Neal - responsible for conceptualizing the structure and mechanism of CAI programs and a co-designer of the simulation.

Dr. Peter Fairweather - responsible for simulation program mechanism design.

Dr. J. Olin Campbell - a co-designer of the simulation.

Dr. David M. Tuttle - responsible for lesson and test design for instructional materials and production of lessons.

Mr. Gary Brown - programmer during early stages of simulation development and responsible for many basic tools.

Mr. Dennis Furse - programmer for the lesson driver and lesson builder programs.

In addition to these major design and production contributions, the efforts of a capable staff of writers and programmers was also important.

DISTRIBUTED INSTRUCTIONAL SYSTEM PROJECT
FINAL REPORT

1.0 Introduction

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2.0 Project Origin and Goals

This section provides a context for the activities of this Phase III project by describing work completed in the two previous system development phases.

2.1 History

In August 1978, the Defense Advanced Research Projects Agency (DARPA) contracted with WICAT to develop the concept and prototype of a Distributed Instructional System (DIS). The goal was a low-cost delivery system using computer-controlled interactive videodisc as a medium, for instruction and 2-D simulation, for both field and school-based military training.

The development effort beginning with design studies and ending with a fielded system was spread over three independently-funded project phases. The first project phase was to be a study and design phase in which military training needs and trends were examined. These needs and trends, once identified, were to be used as the basis for creating a design for a broadly useful and practical military training delivery system. The second project phase was to use the design to construct a prototype system, develop sample instructional materials to be used on it, and run preliminary tests on those materials. The third project phase was to be the full-scale development of instruction and 2-D simulation materials followed by fielding and testing of the system in a school environment.

Phases I and II were accomplished as planned. A series of visits were made by Dr. C. V. Bunderson, Dr. J. O. Campbell and others to a number of training sites within the U.S. Army, as well as private contractors involved in military training development. Trend data was gathered from these sources as well as data on the current status of military training programs, and the results were summarized in a report entitled, "A Causal Framework to Describe Training Needs and Requirements in the Department of Defense." The findings were that a powerful technology base was requisite within military training to satisfy the demands of increasingly sophisticated weapons training, lowering budgets, and fluctuations in trainee quality. The need for a Distributed Instructional System (DIS) for the delivery of training was established in the report.

Concurrent with this study of training needs, a second study of simulation capabilities and requirements was completed after a thorough review of the literature by Dr. J. O. Campbell. A resulting report, entitled "Intelligent simulation and Job-Aiding on a Distributed Instructional System," built on the recommendations of the needs and requirements study. It catalogued the features for simulation and job-aiding which are possible using a system of DIS-like design.

At this point, the design of a DIS system was complete, and the development of a DIS prototype was underway. A description of the system as it was then conceived is presented in Appendix A. The description is essentially unchanged to the present day except for the use of coaxial cable rather than fiber optic links between stations in the present system. Creating the system prototype included construction of individual workstations and their operating software and creation of network sotware for linking workstations to the central storage station.

The Courseware Design System (CDS), a high-level authoring language, was used in this prototype system for lesson development. Eleven lessons of instruction, comprising three videodisc sides, were developed for DIS. These lessons were to be the vehicles for an initial evaluation of the system, its programs, and CDS.

To guide that evaluation and to provide tools for assessing the outcome, two additional reports were produced. The first of these developed the important concept of productivity, in which the instructional process was looked upon as an event requiring a given level of resources and having a measurable level of outcome. The ratio of these was termed the productivity of the system. The

report containing this concept, authored by Dr. J. Olsen, was entitled "Learner and Learning System Productivity" and contained an explanation of the concept, a review of the literature on productivity, and an evaluation plan for an evaluation intended to assess DIS productivity. The evaluation plan called for measurement of several variables in an assessment of productivity attained during use of the DIS.

The second report written to provide a foundation for the evaluation was entitled "A Cost/Benefits Analysis for Implementing the Distributed Instructional System." In this report Mr. T. Compton and Dr. G. Kearsley proposed a unique methodology for projecting the cost implications of implementing a family of training devices within a training program, each with an expected degree of transfer to real job performance ability. The important feature of this cost mechanism was the verifiability of the outcomes of its projections and its potential use, given accumulation of an adequate data base, for projecting the cost-optimal group of training delivery systems for virtually any training project, given the levels of proficiency desired.

By the end of Phases I and II, the DIS system had been installed at the USAADS Ft. Bliss test site ready for an initial evaluation of the instructional materials in the context of MOS 24E10 Integrated Systems Check training. Data collection was begun, but before this evaluation could be completed, a redirection of effort initiated preparations for an enlarged test and evaluation effort under the sponsorship of TDI. This test was to include evaluation of the 2-D simulation, which at the end of Phase II had been partially designed but not developed. Evaluation was also to cover additional instructional materials on videodisc to supplement those already created. A contract awarded to WICAT by TDI in January, 1981 established the tasks for Phase III and the work to be accomplished.

3.0 Approach and Design Rationale

A design for the DIS was created based on the design options and studies from Phases I and II. This design was a composite of the hardware, software, and courseware designs fitted to the specific training needs of I-HAWK training course at USAADS, Fort Bliss, Texas.

Before the design process began, it was known that in order to fill the military training needs identified, the system would have to have certain key qualities, such as:

1. Convenient size, peripheral, and environment requirements. If the system was to be usable in a variety of applications, its demands for peripheral equipment, environment conditioning, and power supply had to be kept to a minimum and had to be standard and widely available.

2. Low acquisition and maintenance costs. The costs for the system and its programs had to be low enough to permit widespread use.

3. High fidelity. The displays and interactions of the system had to have as high a fidelity as possible to real job performance standards.

This refers to the fidelity that problems would require of the student's mental processes, as contrasted with the fidelity possessed by real equipment. The pitfalls of equating fidelity of "touch" and "feel" with fidelity of mental process were recognized. Careful design in favor of both was accomplished where possible, but more importantly in favor of behavioral fidelity.

4. Maintainability. Not only did the system equipment need to be easily maintained, but the software programs administering instruction and simulation needed to be field-modifiable to the extent possible.

3.1 System Configuration

The system description contained in Appendix A has already been referred to. A more detailed description of system equipment is given below.

Workstation Equipment. Each of the four workstations installed consists of the following equipment:

- 1 - workstation computer, WICAT Model 100-DT
- 5 - circuit boards
  - 1 - CPU board
  - 2 - 256K memory boards
  - 1 - workstation communications board
  - 1 - videodisc interface board
- 1 - Panasonic 13" color TV monitor
- 1 - Keytronics keyboard
- 1 - MCA DiscoVision Videodisc Player, Model PR-7820

Each workstation was also equipped with a custom-made hand-held keypad containing a set of special instruction/simulation control keys. These keys are identical to the special keys provided on the Keytronics keyboard, as described in later sections of this report.

Storage Station Equipment. The storage station was connected through a shielded cable to each of the workstations. Storage station equipment installed consists of the following:

- 1 - storage station computer, WICAT Model 100
- 5 - circuit boards
  - 1 - CPU board
  - 1 - 256K memory board
  - 1 - storage station communications board
  - 1 - Marksman disk interface board
  - 1 - floppy disk controller board
- 1 - Century Data Intelligent Marksman 14" Winchester disk drive with integral controller (20 megabytes)
- 1 - Data Electronics high-density cartridge magnetic tape drive
- 1 - Televideo TVl-912C CRT terminal
- 1 - Control Data dual 7 1/2" floppy disk unit

A networking program installed on the storage station enabled storage station communication with the four workstations for the purpose of supplying lesson or simulation data and programs for use by the workstations. The mode of operation within this system is different from the standard time-shared system. Individual workstations, having 512K of memory are capable of downloading entire programs and data bases for independent processing rather than having to communicate continually with the central computer. Access from the workstation to the storage station is kept to a minimum, and intervals between communications may be as long as 45 minutes to 1 1/2 hours. The exceptions to this are the lesson exam process and the logon process, in which interactions are relatively intense for short periods of time. During the exam process, communications take place at an estimated median value of every 2 minutes.

3.2 Program Design

The instruction and simulation programs consist of a family of programs embedded in a matrix of control and administrative programs. Table 1 on page 6 lists the programs, and Figure 1 on page 7 shows the hierarchical relation of the programs to each other.

Note in Figure 1 on page 7 that administrative programs are handled under a separate control program (Terminal Control Program) to prevent student access to administrative data. Lesson and Simulation Maintenance programs have been separated from all other programs to avoid their use by unauthorized persons. The Lesson Maintenance program in particular has been engineered for easy use and modification of lessons. That function, however, is carefully controlled and limited to only certain users to avoid haphazard, unauthorized changes to lessons and potential lesson tampering.

Figure 2 on page 8 shows the availability of programs at the workstation and the storage station. It is not possible for the workstation to run storage station programs, though the opposite is true. This provides further protection from students tampering with the system. The Exam Maintenance program is available at the workstation so that instructors may see how test items will look on the workstation screen. However, access to the program is only available to those logging on as instructors.

The decision process during log-on shown in Figure 3 on page 9. The first interaction is a request for the number of the videodisc side playing and a press of the NEXT key. This allows the computer to set up its input files and adjust to the use of either the hand-held keypad or the Keytronics keyboard. The title page then requests a user number. This title page is a videodisc frame, as are all of the subsequent menus. If a user is logging on for the first time to the system, a system introduction lesson is administered by the lesson driver. This lesson familiarizes the user with the cursor and return keys for entering options.

The system menu is presented, allowing the user to request either simulation or instruction. On this and all subsequent menus the user may select to log-off. If the user is an instructor or manager, the system recognizes this and presents a special instructor menu. This allows not only all student choices

Table 1

DIS System Programs

Program	Description
Lesson Driver	Runs all sixteen of the troubleshooting exercise lessons and all CAI lessons.
Lesson Builder	Maintains the sixteen troubleshooting exercises and all CAI lessons.
Exam Maintenance	Allows instructors to maintain the pool of exam questions.
Exam Driver	Administers exams and stores scores.
Simulation Driver	Runs the simulation of HAWK circuits.
Simulation Maintenance	Maintains the HAWK component description files, the rules files that control the simulation, and the data files required for the simulation.
User Registration	Allows managers to add new users to the system or to delete old ones.
Logon	Logs a student onto a workstation and allows him/her to choose instruction or simulation.
Simulation Problem Generator	Allows the instructors to create new simulation problems for students.
Report Generator	Produces reports for instructors on student progress and on lessons and simulation problems.

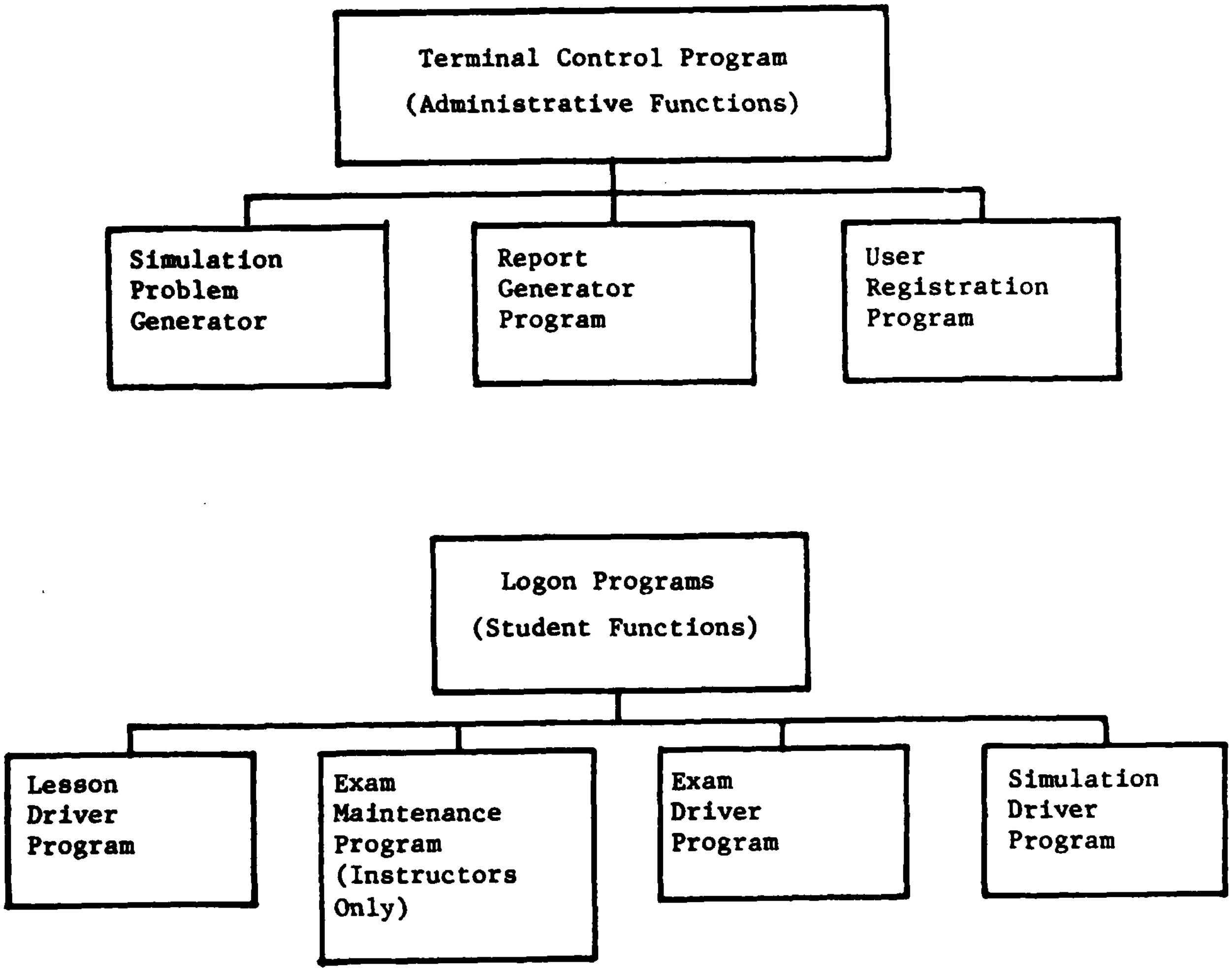


Figure 1

DIS Program Hierarchy

<u>Note</u>: The following programs are not shown within the hierarchy since they are used independently of the Terminal Control and Logon Programs.

- Lesson Builder Program
- Simulation Maintenence Programs

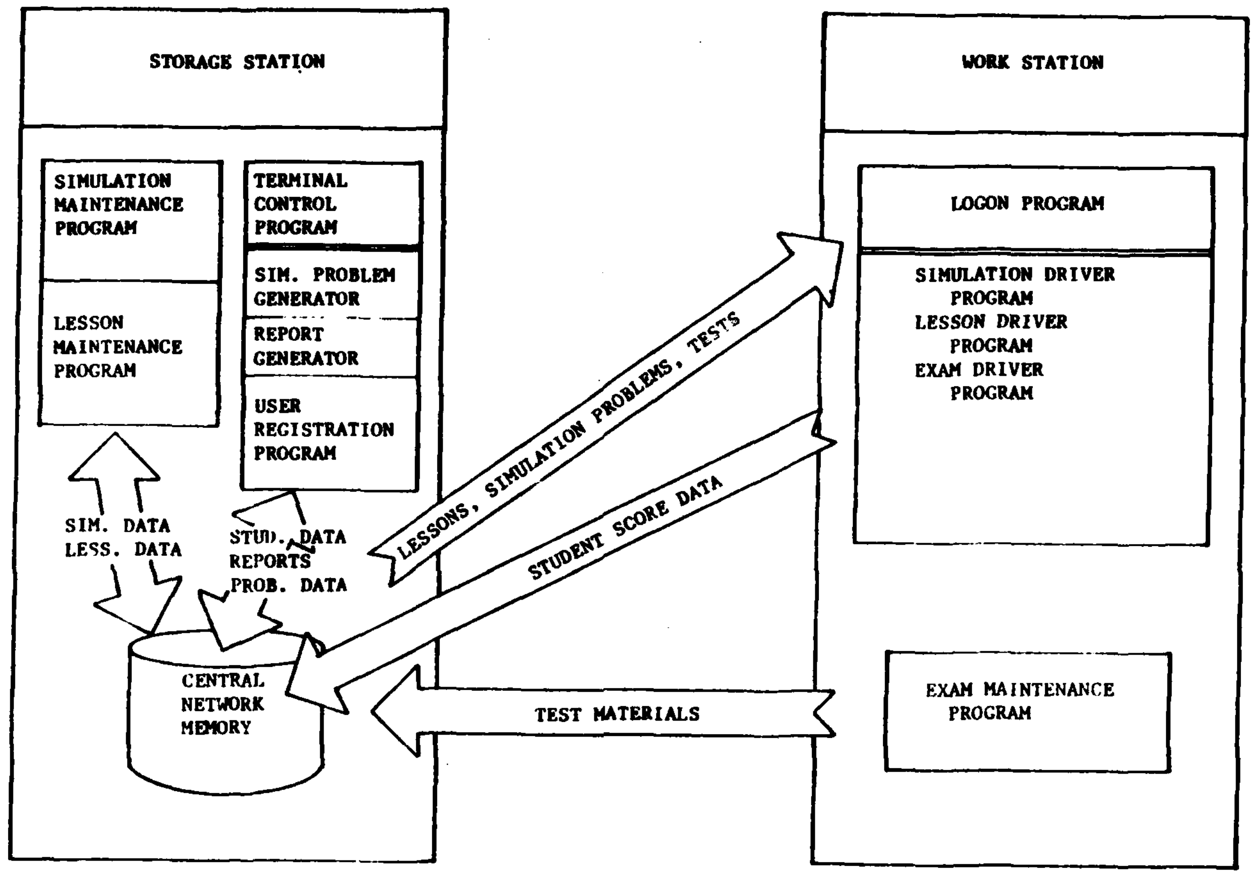


Figure 2

System Programs and Data Flow

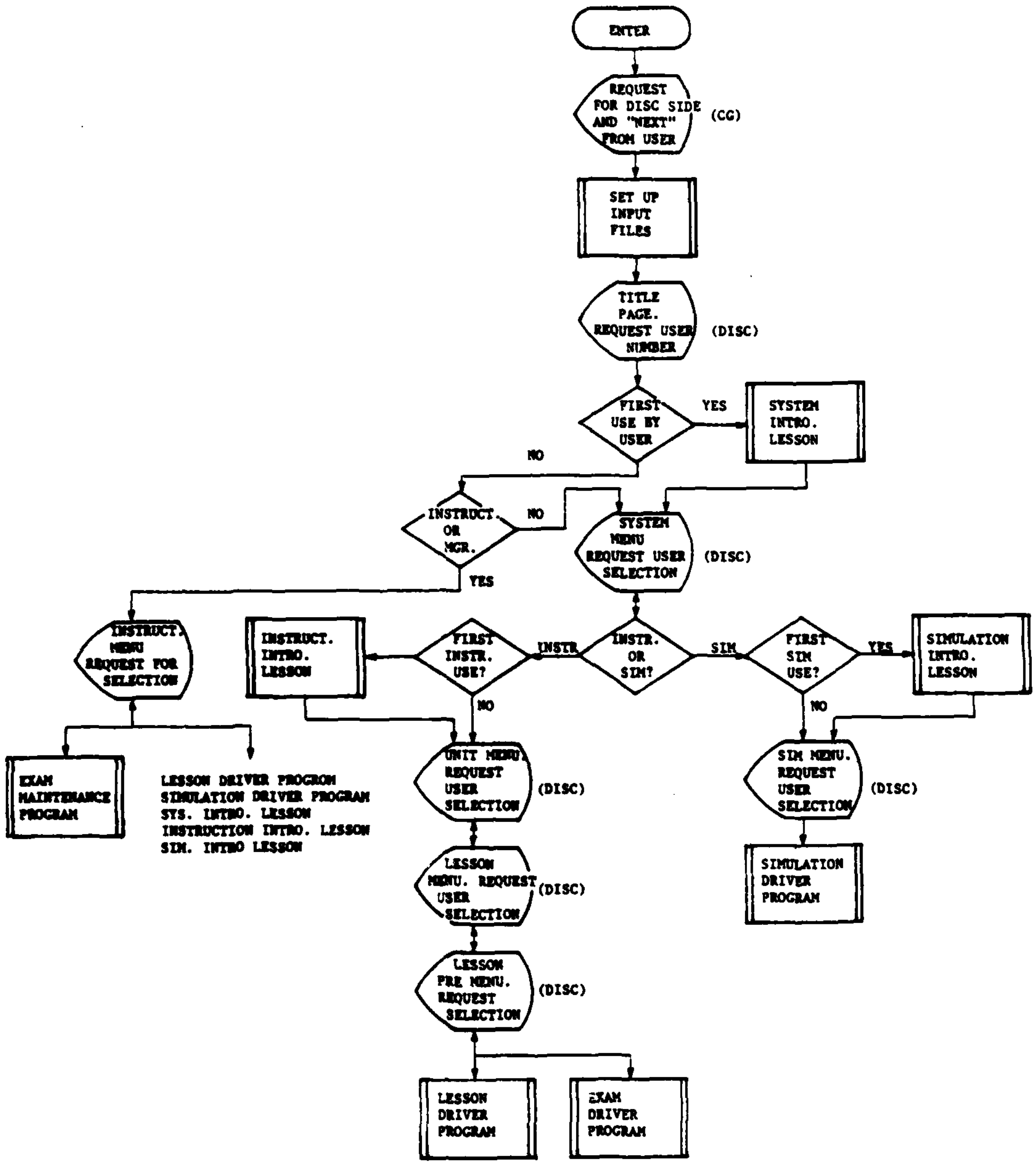


Figure 3

Logon Program Flow

but also the use of the Exam Maintenance program and direct access to all system introductory lessons (Introductions to the System, the Instruction, and the Simulation).

If instruction is selected from the system menu, a check is made to determine if the user has selected instruction before. If not, an instruction introduction lesson is presented by the lesson driver prior to the presentation of a unit menu. This introduction lesson demonstrates the use of the special instruction control keys. The unit menu lists the units available for study; and when a unit is chosen, the appropriate lesson menu is presented. This lists the lessons within a unit. When a lesson is chosen, the lesson pre-menu is presented which allows the user to enter a lesson in instruction mode, in review mode, or to take the lesson exam.

If the user chooses simulation from the system menu, the system determines whether it is the user's first use of the simulation option. If so, it automatically presents a simulation introduction lesson. This lesson demonstrates the use of the simulation control keys on the hand-held keypad. Following the simulation introduction, a simulation menu is presented which lists the problems assigned to the user. The user may select a simulation problem from this menu. It is possible for the instructor to both assign and disable problems from this menu and thus constrain the choice of simulation problems given the user. Once the simulation problem has been chosen, the simulation driver program is called, and the simulation problem is administered.

3.2.1. Simulation Surface Design

The design of the 2-D simulation began with the definition of its scope. It was to simulate a portion of the I-HAWK Integrated Systems Checks (ISC). The missile system is composed of several major operating components (e.g., four types of radar, one Battery Control Central, three Launchers, etc.). Since the missile is designed for use in a move-and-shoot environment, quick set-up and calibration is an absolute necessity. The ISCs are check procedures which allow rapid system calibration and testing after set-up.

During the performance of the ISC, MOS 24E10 maintenance personnel and personnel from several other MOS groups must be prepared to troubleshoot and correct faults as they occur. The specific circuits selected for simulation were those involved in the 4-Parameter Test of the HIPIR/LCHR Check, a test of the missile system's ability to detect, lock on, track, and fire at a computer-generated test target. The 4-Parameter Test is a comprehensive test of most system functions, and the faults it uncovers require maintenance personnel to troubleshoot a broad range of malfunctions of the missile system to isolate problems to major end items.

The 2D simulation was developed to follow a sequence of CAI lessons containing a necessary foundation of knowledge and skills for troubleshooting.

The surface design (user interface) of the simulation is intended to give the student free play on the simulated circuits without direction or correction,

while providing realistic visual and decision-making interactions which require the student to deal with the spatial as well as the electronic realities of the I-HAWK System Battery Control Central (BCC).

Control over the simulation is exercised by a set of simulation control keys available on both the hand-held keypad and the keyboard. A listing of these keys and their functions provides the "feel" of the simulation interactions.

<u>ZOOM-IN Key</u> -- Allows the user to zoom-in to take a close look at a chassis, a meter, a radar screen, a switch, a lamp, or a panel. Zoom-in to 109 different BCC locations is accomplished by entering the location number (given to the user on the locator charts provided at each work-station) and pressing ZOOM-IN. Upon zooming in, the user sees the component in its present state as calculated by the circuit model (described later). If the location is a lamp and the circuit model calculates that the lamp is on, the zoom-in goes to a visual of the illuminated lamp. After this fashion, meters show accurate readings and motion when zoomed-in to, and controls are shown int he settings the circuit model understands them to be in.

<u>ZOOM-OUT Key</u> -- Allows the user to "back off" from the component last zoomed to. If the user is viewing a control, the first ZOOM-OUT press changes the visual to the control's general panel area. Subsequent ZOOM-OUTs will bring up photographic or art views of the console, the wall, and the BCC overhead (bird's-eye view). By pressing ZOOM-OUT, the student can maintain orientation within the BCC and view the major landmarks in the area of most immediate operations.

<u>NAME Key</u> -- Allows the user to obtain the name of the component, control, lamp, etc. being viewed at any given moment. This feature is especially useful for confirming the identity of a chassis which has been zoomed to for measurement purposes. Also, since many controls look similar to the closest zoom-in, the NAME feature allows the user to confirm that the correct meter or lamp is being observed.

<u>BACKSIDE Key</u> -- Is the user's gate behind the panels. Measurement routines require the user to zoom-in to the component being measured, whether a terminal board or a jack. On certain zoom-in frames, the BKSD legend on the screen tells the user that pressing BACKSIDE will open the panel to an interior view. Using the ZOOM-IN key from that point then allows the student to explore or to zoom directly to a measurable component.

<u>SET Key</u> -- Allows the user to change the setting of any of the settable controls. Pressing SET adds to the display a group of setting option boxes and a cursor. When the cursor is placed on one of the boxes and ENTER is pressed, the display changes to show the control in that new setting. At the same time, a message "STANDBY - CALCULATING" indicates to the user that new values for all circuit components are being computed by the circuit model.

TEST Key -- Allows the user to run two diagnostic tests from the ISCs. If the user selects one of the tests (the 4-Parameter Test), successful running of the test after correction of the fault terminates the problem and congratulates the student. If a test is selected but not run, the simulator remembers and asks, after a measured delay, if the test is going to be run.

MEASURE Key -- Allows the user to take measurements at over 600 measurement points. Measurements may use the multimeter, digital voltmeter, or oscilloscope. Measurement types include volts DC, (negative and positive), volts AC, ohms, waveforms, serial words, and volts DC return. The user must zoom to the area of the measurement point before placing probes, either at an appropriate ground or on a measurable point. Illegal measurement points are detected and denied the user. In the case of continuity tests (ohm measurements) and AC voltage measurements involving 3-wire synchro circuits, illegal measurement point pairing is detected and disallowed. When legal points have been selected, the measurement readout is given to the user as a display of the face of a meter, giving the reading as the student would normally receive it under field conditions.

REPAIR/REPLACE Key -- Allows the user to make repairs of parts, replacements, or substitutions to effect a correction of the fault. The user zooms in to the component to be repaired and designates the component by name. In some cases, the problem exists in circuits outside the BCC which the 24E10 is not responsible for. In such problems, the REPAIR/REPLACE function allows the faulty end item (for instance, the radar) to be identified. On correct identification, the problem is terminated. If the repairs made are unnecessary of incorrect, the simulation accepts them without comment and continues the problem. If repairs are made correctly, the student is still obligated to run the diagnostic test to demonstrate that the system is functioning properly, at which time the problem is terminated.

END ITEM Key -- Allows the user to specify a control at another end item of the I-HAWK battery (for instance, the radar) to be set. In addition, readings of indicators at other end items may be checked, and control positions may be determined.

OOPS Key -- Allows the user to recover from mistakes about to be made, but not from mistakes already made. Pressing OOPS allows the user to terminate a measurement, a repair, or a test, or to back out of an end item inquiry.

Figure 4 on page 13 presents a flow diagram of the simulation process from the user's point of view.

As the user chooses simulation from the system menu, the first encountered event is a list of simulation problems assigned to the student. The user selects a problem and the simulator begins an initialization routine in which the circuit model calculates the appropriate circuit values for the problem

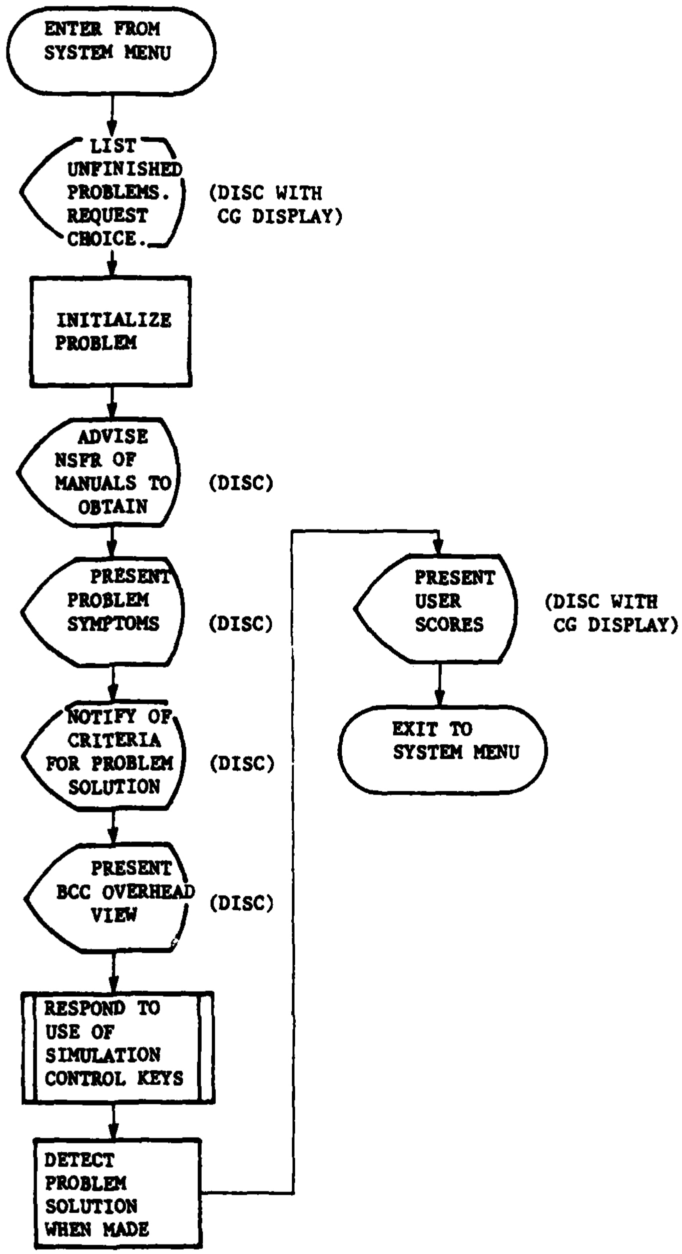


Figure 4
Simulation Process Flow
(user-view)

specified. The circuit model is a part of the simulation program which calculates a value for each of the 1000 components in the simulated circuits. Calculation is accomplished using a set of rules which contains a rule for each component.

During problem initialization the user is advised of manuals which may be used during the simulation and a countdown process indicates the number of seconds before the problem will be started. When the system has initialized the circuit model, a list of the problem symptoms is presented to the user, and the user is notified of the criteria for solving the problem.

From this point the user is branched to a view of the BCC overhead, and the system does nothing except that which the user requests through the simulation control keys. The simulator is capable of detecting when a solution has been reached, and upon correct solution of the problem the user is presented with a set of scores which represent the performance during the problem. At this point the user is invited to inspect the record accumulated during the problem, including the total amount of time elapsed for problem solution, the total amount of "repair time" (the amount of time the problem would have taken in the real world due to replacements and repairs), the number of switches set, the number of indicators read, the number of tests run, the number of measurements taken, and the number of repairs or replacements made. Following this score report, the user is returned to the system menu.

3.2.2 Simulation Internal Design

The operation of the simulation is accomplished by a suite of four main programs operating on a set of data files. The simulation programs and their functions are listed below.

SIMAINT — The SIMAINT program is used to create and maintain the complete component data base used by the simulation program. Each component, depending on its type, has the potential of requiring several different items of data which describe its operation characteristics. Data on those characteristics was initially gathered using a component description form. An example of this form is found in Figure 5 on page 15.

SIMDEF — The SIMDEF program translates circuit equations from the source version, which is human readable, to a form that can be directly calculated by the simulation program. One of the means used to achieve speed within the simulation program was to perform calculations using the fastest mode possible. This program places the rules in the appropriate form for those calculations.

SIMD — The SIMD program is used to generate data files which are actually used by the simulation program. The SIMD program works on the component data base to create the files used when any of the special simulation functions is invoked such as the SET function, or the MEASURE function.

Circ. Diagr. Locat.__________

Funct. Diagr. Locat.__________

Name_______________________ Type_____ Class xxx

System location xx System function group______________________

Troubleshooting technique____________ Difficulty level____________________

Breakable ____ Repairable ____ Measurable ____ Settable_____

Failure Modes

Repair type _____ Repair time______

Replacement time _____ Replacement unit_____________________________

Substitution time ________ Substitution unit_____________________________

____

____

Measurement instrument _______ Measurement time_______

Type of signal ______ Danger point __________

Chassis rear measurement point? _______________

Setting time __________ Number of setting states __________

Initial setting __________ Alternate initial setting _________

Rule:

Figure 5

Component Description Page

SIMDRVR — The SIMDRVR program is the control program for the simulation and drives the execution of the simulation control routines using the data files created by SIMD.

In order to run the simulation, there must be several data files other than the component rules file. Most of these are created by the SIMD program. The major files and their purposes are:

Component File — This file contains the names of all components in the simulation plus the simulation variable number of the component and data regarding whether the component is breakable, repairable, settable, and measurable.

Measure File — This file contains information for all components that can be measured. The data in this file concerns the signal type at a given component, the instrument which can be used for measurement of the signal at that point, identification of whether the point is one of a triplet of measurement points as in synchro wire measurements, and a continuity list number for ohms measurement.

The data in these two files are not used as frequently by the simulation program as other files which will be described. When data from these files is needed, it is read from the storage station memory over the network using a random access KSAM file routine.

The files which are listed below are also simulation data files which are read into the memory of the workstation at the time the simulation program is loaded to the workstation. These files provide fast access to the most frequently used simulation data. They are especially structured to provide fast access to to the data and also to minimize memory use. These files are a second factor used to minimize calculation and response time to the user.

Pointer File — This file contains a set of pointers to records in data files and is the preliminary means the simulation uses to determine components that can be set, chassis from which measurements can be taken, components which can be zoomed-in to or zoomed-out from, components which can be named and components which can be used as a gate to the backside. The simulation program uses this pointer file as the first source of information when a student issues a simulation control key command. If the necessary data to execute the control function is not available in the pointer file, the simulation program knows that an illegal command has been issued and responds appropriately.

Primary File — The Primary File contains a record giving the specific videodisc frame data and other required functional data for each component that can be set, zoomed-in to, zoomed-out from, measured, or used as a backside gate. Records in this file consist of a pointer to the appropriate individual data files.

Measure Data File — This file contains a list of components by name and variable number that can be measured from each chassis.

Set Data File — This file contains data for each settable component which allows the user to set controls and manipulate handwheels. The data contained in this file includes videodisc frame data and setting position data.

Zoom-In Data File — This file contains data for each component that can be zoomed-in to. The data contained in this file includes the number of states the component may be found in and the videodisc frame number to be accessed for each state.

Name Data File — This file contains the name of each component that can be zoomed-in to.

Ohmlist Data File — This file contains lists of components which are chained together in continuity lists for the purpose of enabling ohms measurements. Since the rule structure is incapable of identifying continuity chains within the circuits, this file is necessary to identify legal ohm measurement pairings.

The circuit model, which consists of the complete set of component rules and the simulation driver program which acts upon them, models a total of 800 equations for a total of 1050 components. Many of the equations perform a simple assignment from the output of the previous component to the input of the following component in the circuit. Even in the simplest case of equation, a separate rule must be given for each component because each component can be broken. The existence of a rule enables the effect of breakage on the individual components and subsequent circuit components to be calculated. Secondly, each component is potentially a measurement point and the value for measurements must be calculated and assigned to that point so that when measurement takes place, the appropriate value may be reported. The circuit rules for many components do change the input significantly in their calculation of output values. In some cases, notably in synchro circuits, a single input signal enters a component to result in three mathematically-balanced output signals. The reverse is also true at certain components where three signals converge on a single component and must be converted into a single resultant signal.

Special challenges during the development of the 2-D simulation programs included the variety of signal types modeled by the simulation (including DC voltages, both positive and negative, DC return circuits, varying AC voltages and wave forms). In some cases, notably wave form signals, signal characteristics had to be divided among several "ghost" components which could be broken independently to produce appropriate wave form displays.

A second major challenge of the 2-D simulation included momentary signals and their associated holding circuits. Most component rules are in a file that is processed by the program SIMDEF. This program, as was stated before, translates the equations into a form suitable for computation purposes. Some

rules, however, could not be handled in this manner, either because of time dependencies or because of the complexity of the equation. Momentary action switches and their associated holding circuits and three-wire to one-wire synchro calculations had to be handled in a different fashion. In these cases the component rules were written as subroutines in the 2-D simulation program.

Circuit values are calculated initially during the initialization process for the 2-D simulation problem. They are subsequently recalculated whenever a switch setting is changed by the user or whenever potentiometer or handwheel controls are changed in their position. Circuit values are also recalculated when a component is repaired or replaced. During recalculation of circuit values, multiple passes through the rule set are required which continue until all circuit values stabilize or until a maximum of 10 cycles has been reached. Some broken components cause the values of other circuit components to change continually, and some circuit values never stabilize. For instance, if a radar does not lock on the target which is a symptom of many simulation problems, the radar continues to search for the target. This means that a set of several synchro circuits which monitor radar azimuth and elevation will be in a continually changing state.

A special provision during the simulation for a HELP function was made to enable students to review information or data related to their solution of the problem before the problem is terminated. The HELP key may be pressed at any point in the problem that does not require a specific input. Upon pressing HELP the student receives the option to obtain information on control key functions, see a restatement of the original problem as it was presented, look at a current score report for the problem, or quit and save the problem for restart at a later time.

3.2.3 Lesson Surface Design

The development of lessons for the I-HAWK DIS consisted of two main activities. First, the development of programs and videodisc materials for new lessons; and second, the revision of existing lessons created during previous development phases for use in Phase III on the DIS.

During Phase III, twenty-four new instructional lessons were developed (plus three introduction lessons). The original contract plan specified development of twelve lessons, six of which would be demonstration lessons showing ISCs being performed, and six of which would be "backpanel" lessons demonstrating the flow of signals and data during the ISC Checks. It was originally felt that this combination of lessons would provide an adequate groundwork of information for the solving of troubleshooting problems. During the course of development, it became apparent that the six signal flow lessons would constitute a heavy information burden on the student, requiring more effort on the student's part than was deemed appropriate by USAADS and WICAT personnel.

Based on this realization, the authoring of signal flow lessons was diverted to a set of sixteen troubleshooting exercise lessons intended to serve as highly-guided and path-constrained exercises in troubleshooting. To accompany these lessons and build a foundation for their use, it was determined that a lesson

would also be required to provide students with a standard, acceptable troubleshooting process for use on both troubleshooting exercises and 2-D simulation problems. At the time of contracting such a troubleshooting process was not available from USAADS either as a doctrinal statement or as a concensus product. Ultimately, a process was outlined by USAADS SMEs which satisfies the training backgrounds and practices of the majority of experienced I-HAWK trainers and field practitioners.

It was also determined that the six ISC demonstration lessons would have reduced utility for the student without certain prerequisite information about the ISC being provided in an ISC introduction lesson. Therefore, this lesson was also prepared for use on the I-HAWK DIS System. The final accounting of lessons created during Phase III development is as follows:

1	Introduction to ISC Lesson
7	ISC Demonstration Lessons
1	Troubleshooting Process Lesson
16	Troubleshooting Exercises
3	Introduction Lessons
28	Total Lessons

Seven demonstration lessons were prepared, rather than the six required in the contract. The preparation of the seventh lesson stemmed from the results of the first of the two project evaluations (See Section 4.1) in which it was found that the format of lesson presentation (high audio content) and the technical inaccuracy of the existing HIPIR/LCHR Check lesson hampered student use of the lessons and instructor confidence in it. The "engineering" of the lessons to meet student requirements and information needs as described above were based on the best available advice from USAADS and the best judgment of the contractor. Experience has shown during the evaluation of the lessons that the lessons are an important factor in the success of the system, and that student performance would be less satisfactory without this proper balance between the lessons and the simulation exercises.

Three lessons prepared during project Phase II were "remodelled" for use with the newly created lessons. The approach in the original three lessons consisted of motion video accompanied by an audio message. These lessons were remodelled to fit the general format of the newly-created lessons.

Overall lesson organization into units is shown in Table 2 on page 20. The pattern of usage for each lesson has already been shown (See Figure 3 on page 9). Lessons may be taken in one of two modes — Instruction mode, or Review mode.

Table 2

Lessons and Units Developed

Unit 1: Introduction to the ISC

Lesson 1: Introduction to the ISC

Unit 2: ISC Demonstrations

Lesson 1: Initialization Check
Lesson 2: Par Check
Lesson 3: Cwar Check
Lesson 4: AADCP Check
Lesson 5: IFF Check
Lesson 6: HIPIR/CCHR Check
Lesson 7: ROR Check

Unit 3: Troubleshooting Aids

Lesson 1: Wire Tracing Diagrams
Lesson 2: System Functional Diagrams
Lesson 3: Fault Isolation Directory

Unit 4: Troubleshooting Exercises

Lesson 1: Introduction to Troubleshooting
Lessons 2-17: Troubleshooting Exercises

Instruction mode moves the user through all parts of the lesson to its conclusion. A user selecting to take the lesson in review mode is presented with a menu of the major information blocks in the lesson. The blocks may be chosen in any order.

Lesson contents are organized in a highly modular and regular fashion to facilitate information access. Each item of information within a lesson is clearly labelled by type, and lesson structure for the presentation of information consists of sequences of labelled blocks of information arranged in a consistent pattern. This was found to facilitate initial instruction as well as review for students, and lessons thus organized can be used for either.

If a student elects to take a lesson exam, the exam driver program is invoked. The exam process begins as an instructor enters an exam pass code. The exam pass code secures tests from student exploration and is a safeguard to insure that the test-taker is actually the student represented, preventing the possibility of stand-ins. Following the entry of the pass code, the student views a series of computer-generated test items in multiple choice format. Test length is controlled by an instructor-set parameter for each test. Test items are sampled from a pool of 50 (or less) randomly selected items and are presented to the student up to 3 times for reconsideration of an answer upon his/her request. Should a student take too long on a test, the test is automatically terminated at a given time-out point. This time out point is also set by the instructors. When the student has seen each test item, the exam routine asks if the test has been completed. If not, the routine recycles back to the first test item.

When the student signals completion of the exam, the test is scored immediately and reported to the student as a percentage correct. Then the exam routine reviews each item in turn, the answer given, and the correct answer. Exam items are presented on subsequent attempts based on the student's response on previous attempts. If a student challenges an exam for a second time, it is possible to receive questions from a previous test, but only those which were answered incorrectly. Questions answered correctly on previous tests are removed from the test pool for that student.

Two main interaction patterns were used in lesson design, as shown in Figure 6 on page 22. The Type 1 structure consists of the presentation of information frames followed by a review or inference question, followed by feedback. Feedback consists of knowledge of results (right or wrong) and correct answer feedback for wrong responses. Type 2 lesson structure is used primarily in troubleshooting exercises. It consists of a frame containing an informational message and a multiple choice question. On an incorrect response the student is branched to a wrong answer feedback frame, which then returns the student to the original question frame. Correct response causes a branch to a second choice frame like the first, with its own informational message, question, and options.

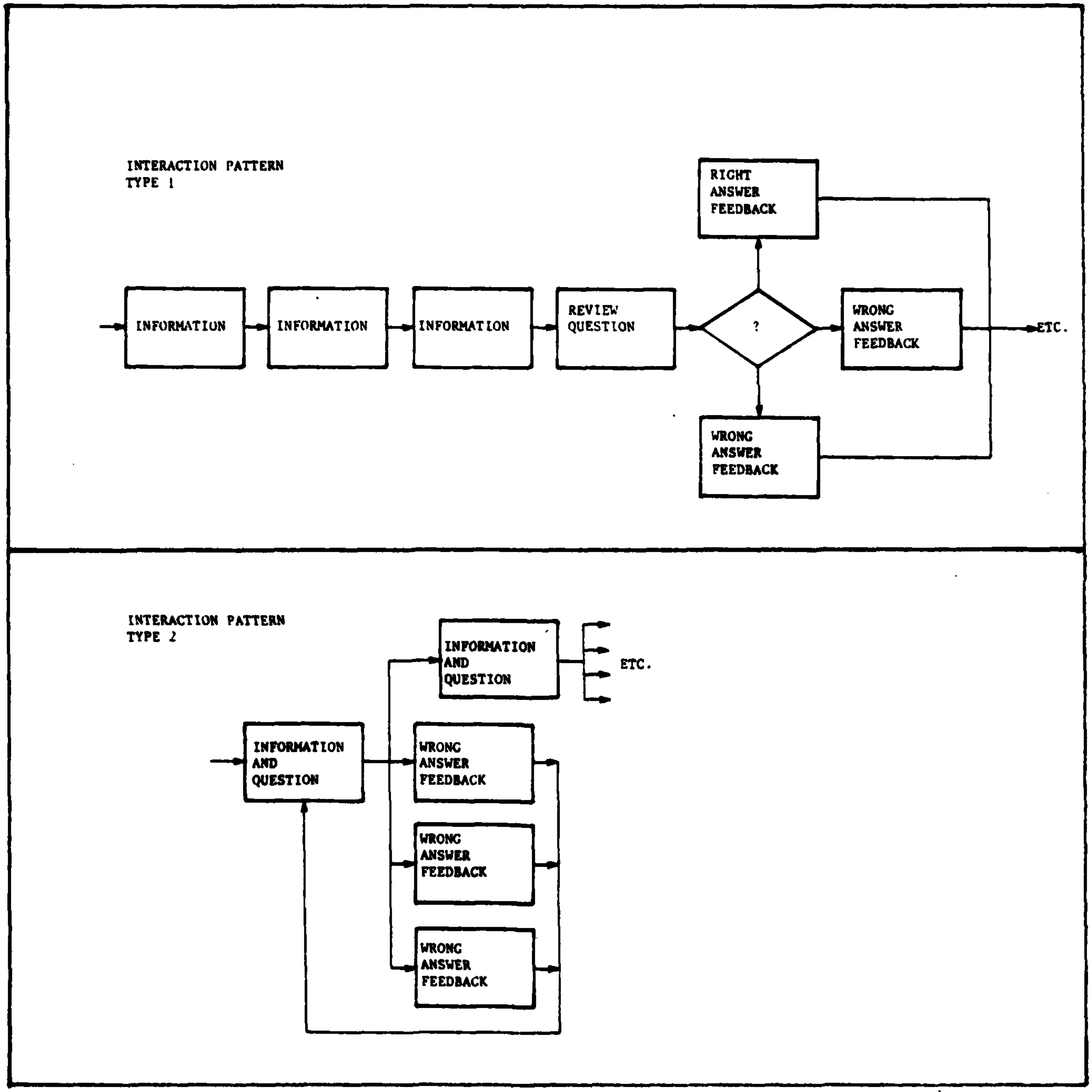


Figure 6

Lesson Interaction
Structures

3.2.4 Lesson Internal Design

The creation and use of lessons is through "builder" and "driver" programs. This eliminates the need for individual programs for each lesson. Instead, the driver program stores lesson data in a file (shown in Figure 7 on page 24). When acted upon by the lesson driver program, the data file executes the lesson. It was possible using the builder and driver programs to create all I-HAWK lessons. This approach to lesson creation simplified data entry, reduced programmer requirements, and simplified debugging and testing of lessons. In the future, the use of these programs will simplify revision of the instructional materials by the training developer.

3.2.5 Utility Program Design

Four programs were created for utility purposes to help the I-HAWK DIS complete administrative as well as instructional functions: the registration program, the report generator program, the simulation problem generator, and the exam maintenance program.

The registration program enrolls students, instructors and managers on the I-HAWK DIS and assigns each a user number. The registration program creates a record file for each enrolled user in which the data used by the report generator program is sorted. The registration program also has facilities for changing user data including the user number, name, and category, and capabilities for deleting registered users.

The report generator program acts upon lesson test and simulation problem score data and creates a series of reports on student performance, individually and by group, and on the performance of lesson exam items and simulation problems. The data in these reports may be used to identify faulty exam items and weak areas of instruction, to grade the difficulty of simulation problems, or to indicate remediation for individual students.

The 2-D simulation problem generator allows the instructor to create a simulation problem and assign it to one or more students. This program also allows instructors to declare problems completed by a student. Through careful use of the simulation problem generator, course developers may create a carefully graded sequence of simulation problems—from relatively simple through relatively sophisticated problems—in an organized fashion to the students.

The exam maintenance program allows developers to control the content, length, scoring criteria, and time-out point of tests. The program is accessed through a workstation by developers so that they may see how test items appear on the student terminal screen. Using the exam maintenance program, developers may create, modify or delete items from the item pool. In addition, they may modify the test parameters for each exam, including specifying the number of items to be presented, the length of the time out period, and the criterion for a passing score. The test maintenance program has been designed for easy use and includes a screen editing capability that is easy to use.

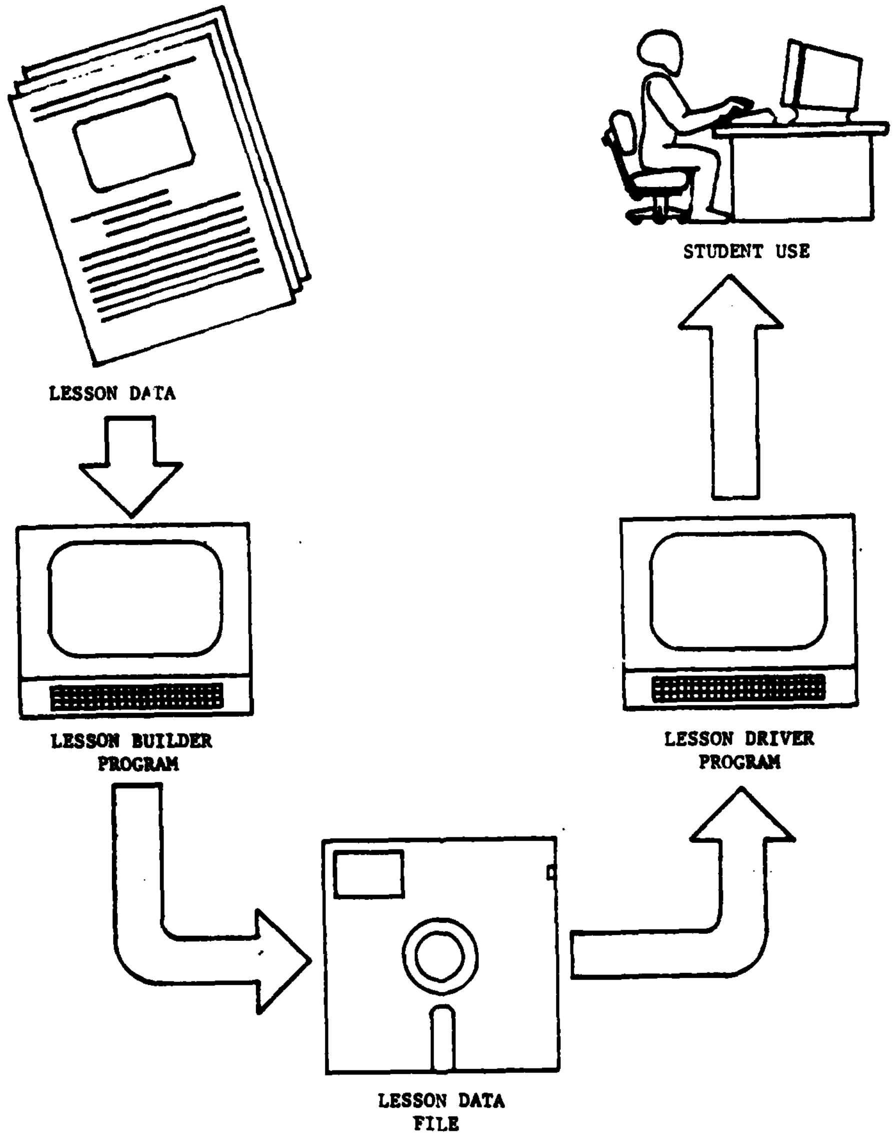


Figure 7

Lesson Programming
Process

4.0 Project Organization

This section describes the work plan used for Phase III activities and names the organizational responsibilities for the program.

4.1 Tasks and Schedule

The work completed during system development was divided into five tasks, accomplished according to the Contract Performance Plan in Figure 8 on page 26.

<u>Task 1: System Support</u>

Task 1 consisted of system installation and support functions and took place in three subtasks.

The equipment described in the previous section was installed during Subtask 1.1 at the I-HAWK Division, USAADS, at Ft. Bliss, Texas. The standard power requirements of the system facilitated this process. No special provisions were required for environmental control except for the shielding and grounding of critical system components to avert the effects of local radar emanations.

Once the system was installed, Subtask 1.2 required the training of Army personnel in the operation and operational maintenance of the system.

Subtask 1.3 called for contractor maintenance support for the system on an "as required" basis. This support included replacement of faulty components, and updates of system programs as required.

<u>Task 2: Hardware/Software Evaluation</u>

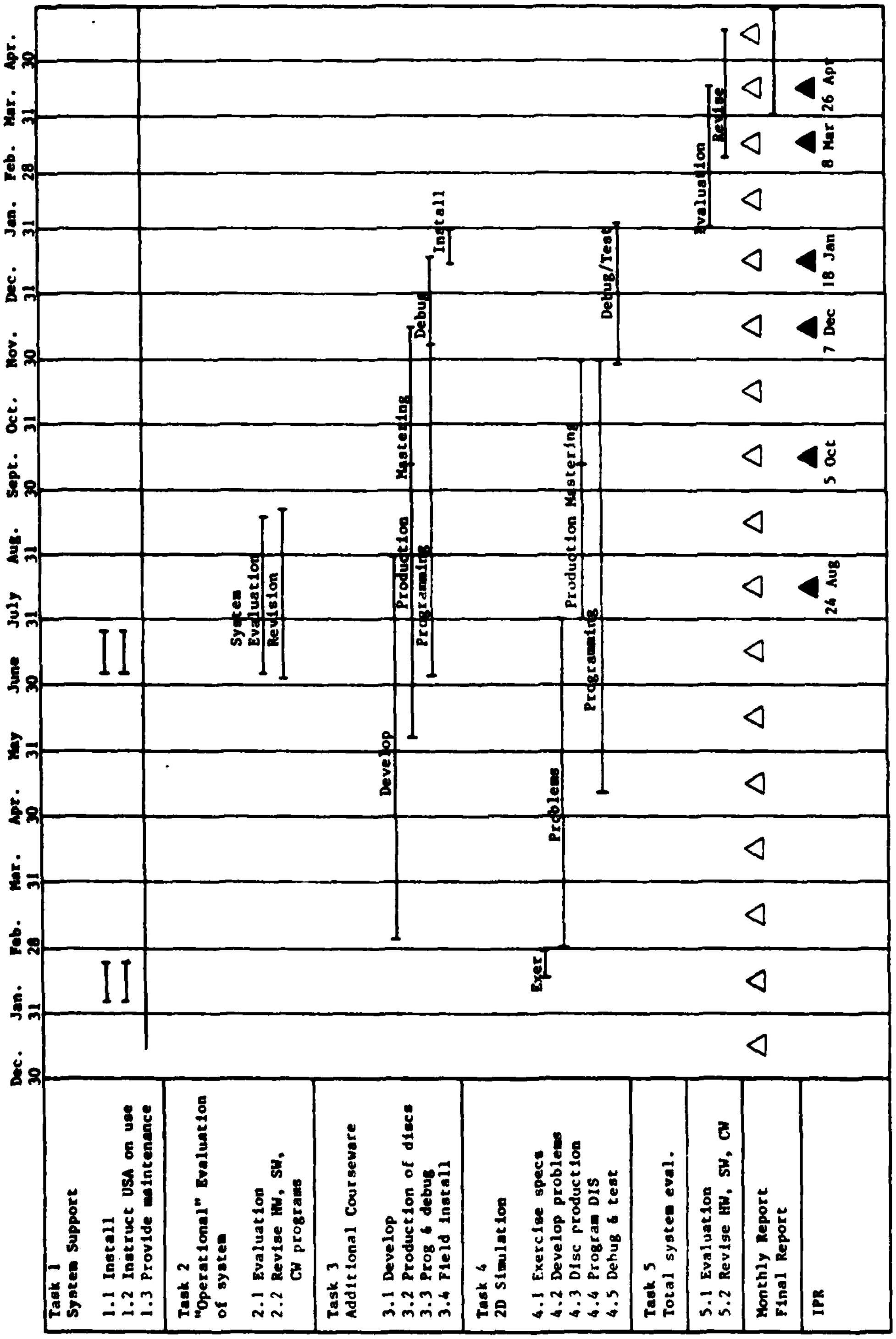
Task 2 provided for an evaluation to demonstrate that the system hardware and operating software were capable of supporting instructional functions reliably. The programs and equipment were to be tested for accurate operation and endurance. A set of benchmark expectancies were formulated prior to the evaluation as criteria for these tests. Subtask 2.1 consisted of the evaluation itself. Subtask 2.2 consisted of changes to hardware and software based on the evaluation findings.

Part of the Task 2 evaluation was also to focus on the determination of which existing lessons developed under the previous contract should be retained.

<u>Task 3: Develop Additional Courseware</u>

Under Task 3, additional instructional materials were to be developed. A set of lessons specified in the contract were to be created for computer-controlled videodisc presentation. These were to be supplemented by lessons retained from the previous contract phase.

Subtask 3.2 involved the development of lessons, beginning with the design of lesson formats specification and policies and continuing through content gathering, authoring, and review of finished lessons. A total of 12 lessons



Dec. 30
Jan. 31
Feb. 28
Mar. 31
Apr. 30
May 31
June 30
July 31
Aug. 31
Sept. 30
Oct. 31
Nov. 30
Dec. 31
Jan. 31
Feb. 28
Mar. 31
Apr. 30
Task 1
System Support
1.1 Install
1.2 Instruct USA on use
1.3 Provide maintenance
Task 2
"Operational" Evaluation of system
2.1 Evaluation
2.2 Revise HW, SW, CW programs
Task 3
Additional Courseware
3.1 Develop
3.2 Production of discs
3.3 Prog & debug
3.4 Field install
Task 4
2D Simulation
4.1 Exercise specs
4.2 Develop problems
4.3 Disc production
4.4 Program DIS
4.5 Debug & test
Task 5
Total system eval.
5.1 Evaluation
5.2 Revise HW, SW, CW
Monthly Report
Final Report
IPR
System Evaluation
Revision
Develop
Production
Mastering
Debug
Install
Programming
Exer
Problems
Production
Mastering
Programming
Debug/Test
Evaluation
Revise
24 Aug
5 Oct
7 Dec
18 Jan
8 Mar
26 Apr

Figure 8

CPP

were required by the contract, half of them demonstrating I-HAWK test procedures, and half dealing with I-HAWK equipment signal flows during those test procedures.

Following development of the lessons, which was accomplished first in script form, Subtask 3.2 required the production of lessons on videodisc. This process required the shooting of motion and still video material using I-HAWK equipment at USAADS, Ft. Bliss. Footage shot was then catalogued and prepared for studio editing, as were the character-generated text material. At the studio, an edited master videotape was prepared. This master was sent to a production agency for production of videodiscs.

Subtask 3.3 specified a programming effort to be carried out parallel to videodisc production. Programs to drive videodisc lesson presentation were prepared.

During Subtask 3.4 the disc and program material was installed at Ft. Bliss in preparation for evaluation.

Task 4: 2-D Simulation

As Task 3 called for preparation of lesson material, Task 4 required the preparation of a 2-D simulation administered by computer-controlled videodisc. The simulation was to pertain to the circuits used for Step 1 of the HIPIR/LCHR ISC Check for the I-HAWK System.

The product of Subtask 4.1 was a specification of problems to be administered by the 2D simulation, including a description of the program requirements.

From that specification, Subtask 4.2 generated the problems themselves, including detailed program specifications and scripts for videodisc production.

Subtask 4.3, 2D simulation disc production, was a process identical to Subtask 3.2 for CAI videodisc production. It was anticipated that footage shot for instruction would be usable for simulation also.

Concurrently, programming for the simulation occurred during Subtask 4.4, beginning as soon as specifications were complete.

Following programming, Subtask 4.5 involved the debugging and testing of the programs prior to installation and evaluation.

Task 5: Total System Evaluation

During the Task 5 evaluation the functionality, effectiveness, and productivity of the system and its programs and materials were measured. Reports written during prior project phases were to be used as process and criterion reference.

Subtask 5.1 provided for data gathering activities, and Subtask 5.2 provided for the revision of programs and presentations based on evaluation outcomes.

4.2 Organizational Participation

The accomplishment of the tasks described in the previous section was through a joint cooperative effort between TDI, ACTO, USAADS, and WICAT, as stated in Section 1.0. Each of these organizations accepted a role in the development effort as shown in Figure 9 on page 29.

5.0 Results and Outcomes

This section describes outcomes of performing the tasks described in Section 4.0 and the results obtained using the DIS system and materials.

By way of caution, it should be emphasized that this project was not a research project. Its aim was the testing of a concept for electronic maintenance training using state-of-the-art training technology. The evaluations conducted during contract task 5 produced student performance data collected in a realistic environment not subject to controls normally used in research and full of the inconveniences of the real training world. The data reported must not be treated as research data, but rather as evaluation or action research data. Statistical analysis has been sparing to avoid the implication that it can be so treated.

5.1 Task 1

The installation of the DIS equipment took place early in the contract period. The installation originally included workstations operating directly from a floppy disk to provide the eleven lessons of instruction created during Phase II. Installation of additional workstations and storage station hardware took place by March, 1981, followed four months later by the installation of the networking software and hardware modifications to support the network programs. Throughout the project, several problems were identified in individual system components including central processing unit boards, memory boards, keyboards and terminals. As problems were identified, the appropriate replacements or repairs were made.

Training of Army personnel in system operation and operational maintenance took place on a continuing basis throughout the contract period, but more particularly during the final stages of program development. In addition to direct training on system operation, many modifications to control programs and system booting procedures reduced the amount of operator involvement to a minimum and simplified the operator's task. A summary of system operating procedures in the latest version is contained in Appendix B and a summary of system maintenance procedures is presented in Appendix C.

5.2 Task 2

Task 2 hardware and software evaluation was carried out midway in the contract period. The plan which formed the basis for that evaluation is presented in Appendix D. The results of that evaluation determined the soundness of operation for the system, its operating software and its networking software. The subjects of the evaluation for the eleven lessons created during Phase II

Organization	Function
Directorate of Training Developments, U.S. Army Air Defense School (USAADS) Ft. Bliss, Texas	Provided subject matter expertise and technical material. Supplied current training data and course outlines. Supplied simulation circuit data. Reviewed lesson scripts, programs and simulation programs. Participated in studio editing process as technical reviewer.
U.S. Army Training Developments Institute (TDI) Ft. Monroe, Virginia	Provided project funds. Monitored contract. Reviewed plans and proposed designs. Offered technical consulting on designs.
Army Communicative Technology Office (ACTO) Ft. Eustis, Virginia	Monitored contract. Reviewed plans and proposed designs. Offered technical consulting on designs.
WICAT Systems P. O. Box 539 1875 South State Street Orem, Utah	Carried out tasks and schedules for design and development of the system as described.

Figure 9

Organizational Functions During the Project

were run according to the schedule described in the evaluation plan and measured against the criteria stated there.

The evaluation demonstrated the general soundness of the system. In addition, behavior of system software and hardware resulted in several modifications and improvements. Improvements included the decision to use the hand-held keypad for student interface, revision of system operating procedures for ease of use by system operators, and the modification of system networking programs for improved reliability and speed.

5.3 Task 3

During Task 3, the additional instructional materials described in Section 3.0 of this report were developed, and lessons which had been created during previous phases of the project were modified.

Lessons were authored using Army technical documentation and the skill and knowledge of Army subject-matter experts. Course material was collected on a set of special forms designed for information collection. These capitalized upon the regular informational structure of the lessons. The forms were completed from technical manual information by contractor personnel and were then submitted to Army subject-matter experts for completion and for supplying of information not available in the technical manuals. In this fashion content was gathered over long distances for a large number of lessons involving highly technical content. The authoring of the troubleshooting exercise lessons was accomplished with dedicated in-person working sessions for lesson authoring. Following format design of these lessons, WICAT personnel worked directly with Army subject-matter experts to author them.

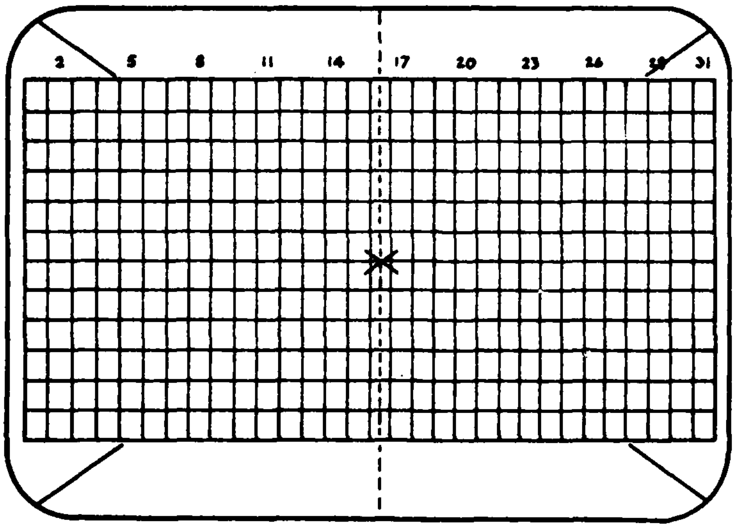
Lessons existed from Phase II and materials for the Glossary were examined during this period and reconditioned to fit format requirements for the new lessons.

Lesson authoring took place using a special set of production sheets. The sample production sheet is presented in Figure 10 on page 31. The production sheet was designed especially for the creation of computer controlled videodisc lessons and contains information needed by a variety of production personnel involved in lesson creation; they include television studio personnel required during editing, television technicians required during preparation of text frames, photographers and video specialists required during photographing and videotaping of required visual materials, graphic artists required during the production of required graphics materials, instructional developers and subject-matter experts required during the authoring and review of lesson materials, and computer programmers required during the creation of lesson programs. The production sheet used on this program was a customization of production sheets used on other projects.

A process of reviews was set up in conjunction with Army subject-matter experts for the purpose of insuring the technical accuracy and appropriate level of presentation of the instructional materials. These reviews were imbedded in a set of clearly defined authoring procedures which covered the actions of both contractor lesson writers and Army lesson reviewers.

Less. Author Frame
No. _____ Code ____ ____ ____ to ____ ____ ____ No. _____

Comp.
Page _____ SMPTE ____ ____ ____ to ____ ____ ____



Graphics: ☐ A ☐ F No. _____
☐ VS ☐ VM ☐ V

☐ AN ☐ OV ☐ SP ☐ QU ☐ WIN ☐ WIP

____

____

Instructions: ☐ FF ☐ SF ☐ RM ☐ PS ______________________________

____

Audio: ____

____

____

____

Figure 10

Sample Production Sheet

The production of materials leading to the creation of the instructional videodiscs began with on-site visits at Ft. Bliss for the purpose of photographing and videotaping still pictures and motion sequences of I-HAWK System equipment and operation. Existing materials photographed and videotaped during the Phase II development effort were also catalogued and prepared for use in the making of Phase III videodiscs. Concurrently, with the shooting of footage at Ft. Bliss, preparation began at the contractor's work site for video text frames. In total, the production effort expended for Phase III production of lesson materials included a total of 6634 individual character generator text pages, 1620 individual slides and 120 minutes of videotape footage shot.

During studio editing of the videotape master, 500 of the 1600 slides were actually used and a total of 7000 edits were made.

The master videotape was sent for videodisc production to DiscoVision Associates, and a check tape was requested for proofing of the disc master contents.

Programming of the lesson builder and lesson driver programs proceeded in parallel with the production process, and upon completion of the programs data was entered for lessons and lessons were tested.

5.4 Task 4

The greatest requirement for data transfer between Army subject-matter experts and the contractor came during the creation of simulation programs and data bases. Simulation data gathering involved identification of components to be simulated and a charting of the behavior of each component through the construction of a rule set describing component behavior. Each rule expresses the influence of the component on signals input to it. Data gathering on the simulation components took place early in the project and continued until the end of the project on an intensive basis.

Photography and videotaping and generation of video text pages for the simulation was combined with that for the instruction. Twelve hundred such pages were created for the simulation alone. Three thousand five hundred sixty slides were taken. Sixty minutes of videotape were shot, and ultimately 3200 slides were used in the production of the simulation. A total of 4083 edits were made for the simulation. An Army subject-matter expert was present for the editing process both for the simulation and lesson editing.

The evaluation took place in four phases:

- Phase 0 - Quality assurance and pre-installation formative review
- Phase I - Instructor training and orientation during installation
- Phase II - Evaluation of full system implementation with individual and grouped students
- Phase III - Full class system evaluation

5.5.1 Phase 0 Results

Phase 0 activities consisted of a formative review of lessons by a representative population of I-HAWK Maintenance Repair Course students. As these were not available to the contractor locally, students from Utah Technical College and Brigham Young University were used. The review of materials was integrated with data entry. After a block of data was entered, it was reviewed for data accuracy and message values.

The results of this review were mixed, and fell somewhat below expectations. Many changes to lessons did take place as a result of the review, but not all that were required. Consequently, the review and correction begun at WICAT's work site had to be completed at the test site prior to use of the system by students. By the time Army students interacted with the lessons, most major problems had been solved, and any additional problems encountered were relatively minor and easily corrected. The efforts of the Subject-Matter Experts (SME) during this test site review were invaluable. Both content and data errors not detected earlier were spotted and corrected during the review.

Following installation of programs at the Ft. Bliss test site, tryout of the materials with student-like subjects was possible, using one 24C10 student and one Warrant Officer who thoroughly reviewed the lessons. Following their review, each was given a questionnaire to complete and was interviewed. The result of this data gathering is summarized below. The MOS 24C10 student found:

1. The regular pattern of lesson organization was very agreeable, since it allowed him to leave a lesson and return to it later without the need to "warm-up" again.

2. The embedded quizzes were very useful for information recall. The student recommended the creation of a carry-away data book, a suggestion not implemented due to the possibility it might dilute dependence on the Technical Manuals.

3. The videodisc-based instruction was deemed superior to book instruction. The student expressed an interest in further instruction using this medium. (The student's interest was demonstrated as he returned twice on his own free time to view lessons.) This opinion persisted even when at one point some program difficulties were being experienced.

4. The student recommended the inclusion of more audio, though he found the text easy and clear to read. He said he often became bored with other mediated lessons but found these lessons interesting.

5. The student emphasized the importance of the instruction as a question-answering resource.

The Warrant Officer, an experienced user of the ISC, indicated the following:

1. The lessons cleared up many details which were previously unclear and provided a valuable new perspective. Some of the Troubleshooting Aid lessons clarified information which he had misunderstood before.

2. Use of the lessons within HAWK batteries was recommended because they contain information on procedures and Technical Manual data unfamiliar to most field personnel.

3. The textual approach was preferred to the audio, but the delay in loading a lesson onto the work station from the Storage Station was considered tedious. This remark was made almost universally by evaluation subjects.

4. The hand-held keypad was preferred over the keyboard for inputting responses.

5. The carrel work surface was felt to be too small and needed a table to be placed in front of it. This opinion was also widely held among evaluation subjects.

5.5.2 Phase I Results

Training of instructors took place at first in early March, 1982 with a group of three instructors. Adjustments in the assignments of the instructors made it necessary to train a second group of two instructors later during the month of March. Instructor training ran two days and consisted of a brief introduction and demonstration of the equipment, the instructional and simulation materials which had been prepared, and the procedures for operating the system to implement the materials. Following this, instructors were allowed to take lessons and exams as students. User aids which were available at training time were demonstrated to the instructors. As new materials became available, they also were demonstrated for the instructors.

The changing role of the instructor during the evaluation was stressed strongly, as it was seem as a new role and different from the one they were used to assuming. The instructors were briefed on the goals and procedures of the evaluation and their role in carrying out the evaluation. That role was portrayed to them as an opportunity to direct, answer questions, probe for student problems, diagnose, and remediate, rather than to act as the primary source of information. These new functions were ones they themselves had stated were more important than information delivery. The goal was to show their time was being reallocated to functions they knew were more important and more difficult. It is felt that this perspective was critical to the success of the evaluation and that in future applications of the system it will be an important key to success.

Following the instructor training, the two instructors were interviewed and given questionnaires to complete. The results were very favorable, and a summary of the comments and questionnaire results is given below:

1. A small number of inconsistencies in the lesson content and ISC procedure were noted.

2. Several details, pertaining to I-HAWK training practices were recommended for inclusion in the lessons, to help students identify deviation from Technical Manual documentation.

3. Both instructors remarked that they were sure students would appreciate the lessons and offered advice on methods for using the lessons with students individually and in groups. One instructor did use the lessons during training with a group of Allied students and said the response of the students was very positive.

4. Both instructors suggested courses other than the MOS 24E10 course which could benefit from the use of the lessons. Recommendations for tailoring the lessons to those audiences were also given, including adjusting, in some cases, the level of detail given in a lesson. The level of content was, overall, seen as appropriate for MOS 24E10.

5. One instructor felt that the other instructors should take the lessons and felt that this would convince them of the soundness of the method of instruction.

6. One instructor recommended the use of the system at a tactical site as a training tool for skill maintenance.

7. Both instructors spontaneously volunteered to return at the next opportunity to look at additional lessons and did so.

Based on the responses of the instructors to this training, the materials were modified and enhanced, and improvements to the Lesson Driver program were implemented. In addition, slight changes in the strategy used with students were considered.

5.5.3 Phase II Results

Formal evaluation was conducted using three separate evaluation groups of MOS 24E10 students. A total of 46 students were treated for data gathering purposes. Sixteen students made up a control group who were given normal classroom instruction followed by a performance post-test administered by evaluation personnel. The remaining 30 students were given some combination of CAI lessons and 2-D simulation problems interacting with the DIS, followed by the same performance post-test. Of the 30 students who were instructed on the DIS, 10 were given CAI lessons only. The remaining 20 students were given both CAI lessons and 2-D simulation problems. The split selection of students from three successive classes (classes 1, 2, and 3) of MOS 24E10 students caused a variation in the sample sizes between the control group and the two evaluation groups.

Random selection of students within each class to the three evaluation groups was not possible. Selection was conducted by class instructors who were advised by the evaluators to select randomly, but the instructors did not report their methods of selection and were not willing for selection to be made by the evaluator using formal tools. Evaluators needs and interests were accommodated in some cases by instructors as requested, but not in all. The resulting class and total distribution of students among the three classes is shown in Figure 11.

Method of Instruction	Control Group	Evaluation Group	
		CAI Only	CAI and 2D Simulation
Class #1	6	10	0
Class #2	5	0	12
Class #3	5	0	8
Total	16	10	20

Figure 11

Distribution of Students Across Groups

5.5.3.1 Procedures for Phase II

A standard method of treating students was developed for the evaluation. Students were greeted by an instructor who briefed them on the purpose of the instructional procedure. Students were then assigned a workstation and student number for log-on purposes. Each student was then given a lesson assignment record and the instructor described the agenda of lessons and/or simulation problems for the day. Students were then instructed to enter their student number. Instructional sequences were presented and guided the student through instructional presentations on using the keypad keys to control the system. Breaks were inserted during the instructional period at spaces approximately an hour apart, and all students were notified of the break and allowed to go at the same time. At the end of the instruction period, or as soon as the student completed the agenda of lessons and problems assigned, they were presented closing remarks and instructions for the succeeding instructional or testing period by the instructor.

In order to obtain data on the various methods of presenting instructional materials and simulation problems, the daily routine of the evaluation was changed between evaluation Classes 1 and 2. Class 1 instruction was provided in an initial one hour instructional period and a second eight hour instructional period. It occurred to the evaluators that the unbroken eight hour period of system use might introduce a fatigue factor for students. It was also found that nine hours of instruction rushed the students too much. It was decided with Class 2 to increase the total instructional time from nine hours to twelve hours and to provide those twelve hours as three blocks of four hours each.

Students in all classes received roughly the same body of CAI instruction consisting of:

- Introduction to ISC's Lesson
- Initialization Check Demonstration Lesson
- PAR Check Demonstration Lesson
- Step 1 of the HIPIR/LCHR Demonstration Lesson
- Fault Isolation Directory Lesson
- Introduction to Troubleshooting Lesson
- Troubleshooting Exercises (1-3)
- Simulation Problems (1-3)

Class 1 did not complete troubleshooting exercises but was able to take the other lessons listed above. All students in Classes 2 and 3 completed troubleshooting exercises. Students were instructed to work at their own speed insofar as possible. In roughly half the cases, two students were assigned to work on one terminal together. Because students worked at their own speed, no control was attained over the exact amount of material covered. Amounts covered varied widely due to several factors, including sickness, pay check pickup, and barracks duty, all of which drew students away from all evaluation groups in an unpredictable pattern.

No pretest was used in any of the groups to assess incoming ability, skill, or knowledge level.

Because of time constraints during the testing, the test item administered consisted of one fault isolation test, with the same problem being used for all students. During the examination the student would interface with a subject-matter expert and a data recorder. The subject-matter expert would present the original problem (see Appendix E for the problem presented) and respond to questions by the examinee. The examinee could ask for operations to be performed such as setting a control, running a test, or viewing an indicator. Students asking to take measurements were asked for probe placement points and type of measurement to be made (e.g., DC voltage). Responses of the tester were limited to responses to student-initiated inquiry, and no information related to the problem was volunteered.

The recorder wrote the words of the instructor and the student during the test. The recorder also timed student problem solving time using a stopwatch beginning with the completion of the statement of symptoms by the tester and ending when a correct solution was achieved. The problem was allowed to proceed until the student admitted verbally that his/her resources were exhausted or that he/she had no idea what to do next. In a very few cases, when the time elapsed had exceeded 20 minutes and no solution had been reached and the student's actions indicated aimlessness or randomness, it was asked whether the student had an idea of what to do and whether the student chose to terminate the problem. In no case was the termination forced if the student was willing to proceed. The tester always indicated a willingness to proceed with the test if the student desired.

The period between instruction and examination was from one to three days. The length of the period appeared to have no effect on the performance of the students.

5.5.3.2 Data Summary

A summary of the test results is presented in Figures 12 and 13 on pages 39 and 40. Figure 12 presents a summary of student problem solving times for each group. Figure 13 summarizes the number of students in each group completing the terminal fault isolation test problem successfully. The original plan was to devise an elaborate scheme related to the problem solving procedure which would give credit for each step of the troubleshooting procedure properly applied, but in fact the large number of students in the control group who did not even complete the problem before it was terminated indicated that a detailed level of scoring was unnecessary.

The following conclusions are drawn from Figure 12 and 13 data. First, only 25 percent of the students in the control group were able to solve the test problem. Second, since the instruction only evaluation group was successful without exception in solving the problem, we conclude that the CAI instruction contains sufficient information required by the students to solve integrated system troubleshooting problems within the domain tested. Third, since the instruction and simulation evaluation group students solved the problem correctly and did it in half the average time of the instruction only group, we expect that the simulation has the effect of further improving the students' efficiency at problem solving once that skill has been established. This is not clearly supported, however, due to the confounding of two other factors--lack of troubleshooting exercise experience and changed instructional day format--both of which were true of CAI only students and not of CAI and simulation students.

No inference is made concerning the breadth of the skill which is established by the instruction or the simulation. Additional evaluations to determine this are required and recommended. Preliminary data gathered during the evaluation through the testing of some students on more than one problem indicates that for evaluation group students receiving instruction only, the effect is consistent across all types of circuit covered in the instruction and troubleshooting exercises and would thus be expected to generalize across all circuits which the student has been exposed to during training on the DIS.

Attitudinal questionnaires were filled out by students to determine the relative preference of students for the instruction they had received and to identify what they considered to be its strengths and weaknesses. Of the 46 questionnaires handed out for completion, only 21 were returned, as the collection was done by instructors. A sample questionnaire is presented in Appendix F.

General trends appeared within the questionnaire data. The control group preferred the instructional method used in the DIS over other training methods. Especially notable in this preference was the high degree of positive feeling toward the troubleshooting exercise lessons. Only one form of training received a higher favorable response among students and that was the practical exercise using real equipment. It is apparent that even though students reach the level of skilled performance using lessons and simulation, they do not feel fully confident of their skills until they've had the opportunity of trying them on real equipment. This is reasonable, since it is real equipment which

Control Group	Evaluation Groups	
No CAI Instruction No Simulation	CAI Instruction Only No Simulation	CAI Instruction and Simulation
(n = 16)	(n = 10)	(n = 20)
12 min. 45 sec. (T)	4 min. 5 sec.	2 min. 0 sec.
23 min. 44 sec. (T)	7 min. 14 sec.	13 min. 55 sec.
24 min. 4 sec. (T)	8 min. 0 sec.	9 min. 0 sec.
14 min. 0 sec. (T)	5 min. 45 sec.	6 min. 2 sec.
17 min. 52 sec. (T)	8 min. 50 sec.	5 min. 12 sec.
18 min. 19 sec. (T)	11 min. 55 sec.	4 min. 7 sec.
11 min. 8 sec.	14 min. 55 sec.	4 min. 3 sec.
18 min. 39 sec.	14 min. 20 sec.	5 min. 55 sec.
17 min. 31 sec. (T)	14 min. 0 sec.	3 min. 40 sec.
7 min. 7 sec.	10 min. 25 sec.	6 min. 25 sec.
9 min. 52 sec.		2 min. 56 sec.
13 min. 45 sec. (T)		3 min. 38 sec.
30 min. 0 sec. (T)		5 min. 9 sec.
7 min. 22 sec. (T)		4 min. 2 sec.
9 min. 20 sec. (T)		2 min. 58 sec.
10 min. 29 sec.		6 min. 11 sec.
		4 min. 20 sec.
		3 min. 10 sec.
		3 min. 8 sec.
		3 min. 0 sec.
(T) = terminated before solution achieved		

Average Time for Solution When Achieved
(Terminated Problem Times Not Counted)

9 minutes 39 seconds	9 minutes 56 seconds	4 minutes 57 seconds

Average Time for All Problem Attempts
(Terminated Problem Times Counted)

15 minutes 22 seconds	9 minutes 56 seconds	4 minutes 57 seconds

Figure 12

Test Scores for All Students

	Control Group	Evaluation Groups	
	No CAI Instruction No Simulation	CAI Instruction Only No Simulation	CAI Instruction and Simulation
Number of Students Tested	16	10	20
Number of Students Solving Test Problem	4	10	20
Percent of Students Solving Test Problem	25%	100%	100%

Figure 13

Summary of Students Successfully Completing the Test Problem

students will be repairing. However, given the strong trend in the performance data in Figures 12 and 13, it also appears true that students can achieve a high degree of skill on the simulation to give them confidence as they move to the real equipment, increasing the effectiveness of real equipment time.

Several themes ran through the students' comments about major likes and dislikes of the system as uncovered in interviews made at the performance test. The most popular features of the system consistently tended to be the self-pacing, the clarity and understandability of the message due to its organizational properties, the benefits of having the instructors, the realism of the problems, and the general inherent interest that was a part of using the system.

Among the major dislikes of the system were the low degree of audio and high degree of reading (though opinions were divided on this issue about equally) programming bugs, the length of the introductory and demonstration lessons, and the characteristics of certain displays (particularly the brightness of certain displays and the "jitter" associated with the videodisc picture).

Commonly recommended improvements in the system included additional time for instruction to take place, which was an interest expressed by several students who found there were lessons they wanted to take but did not have time for, the addition of audio, the elimination of program bugs and the addition of certain features which would make it easier for the student to have mobility into and out of lessons. Several students spontaneously recommended the use of the system at tactical sites both as a job aid and as an instructional and practice source. Some students recommended expansion of the simulation to include more than the present circuits.

The reaction to the hand-held keypad was highly positive, and no negative comments about it were received, with the exception of some students who indicated that the temporary lettering on their keypad keys was beginning to wear off. Almost universally the hand-held keypad was preferred over keyboard, touch screen, or light pen, all of which were specifically mentioned. Some problems were encountered with the position of the HELP button. Some students mentioned that the keys on the keypad were in themselves a training aid and a reminder of functions available to the troubleshooter.

Recommendations for addition or elimination of materials from the system included addition of materials on individual end items in the I-HAWK system. Some students in Group 3 did not feel that the Demonstration lessons had a purpose. However, students from that same class who received neither instruction nor simulation found themselves unable to run integrated systems checks in order to solve the troubleshooting problem. Therefore, we conclude that there was a use for these lessons, but one not perceived by the students.

Parts of the system indicated as most beneficial by the students included the close relationship between lesson objectives and lesson content, the lessons on the use of troubleshooting aids and diagrams, the troubleshooting exercises, and the lesson on troubleshooting process. The simulation (usually referred to as "troubleshooting problems") was most often mentioned as the major beneficial

feature of the system. Questions 7 through 23 of the questionnaire asked the student to rate the system using a scale of 1 to 5 on several factors. A summary of the results of those ratings is presented in Figure 14 on page 43. A value of 1 indicated agreement with the statement and a value of 5 indicated disagreement with the statement. Values of 2, 3 and 4 indicated moderate agreement or disagreement or neutral feelings.

Questionnaire results show that students agreed strongly that the organization and sequence of lessons was easy to follow, that they would recommend these lessons to other soldiers, that the lesson content was clear and easy to follow, that the keypad was well marked and easy to use.

They agreed that the lessons covered about the right amount of material, that they would take another course using this type of instruction, that they would encourage their friends to take this type of instruction, that the time passed quickly while they were using the system, that the content of lessons was at about the right level of difficulty, that the simulation exercises were well done, that the visual displays were easy to read and understand, that the motion sequences helped learning and that the simulation exercises helped improve ability to troubleshoot problems with the I-HAWK Integrated Systems Checks.

The students tended to agree with the statement that they knew where they were in the lessons and where to go next, but were not as strongly positive as on other items, indicating a need for stronger orientation for the students concerning the lessons to be taken and feedback on their progress through the lessons. Students agreed somewhat with the statement that their interest in the HAWK System had increased because of these lessons. It would be surprising if this item had received too strong a response, since 24E10's at this point in their training are considered to be professionals already interested in their professional skills and the equipment that they are training to work on.

Students' questionnaire responses to question 18 show they appear to be neutral on the quality of the CAI lessons. Several interview and other questionnaire comments, however, indicate that students enjoyed the lessons and felt the content in them was appropriate and worthwhile. An interesting trend in attitudes toward the lessons is apparent. Groups 1 and 2 rated the CAI lessons very highly, as did the members of Group 3 of lower military rank. The more experienced members of Group 3, however, rated them very negatively. It is possible that this as well as low Group 3 ratings on other items are due to the fact that the DIS materials and simulation met fewer needs because those students had more extensive experience with the I-HAWK System and its procedures. One of these more experienced people had 4 years of I-HAWK experience, and the second had 8. It is to be expected then that this simulated training would hold less interest and benefit for them.

Finally, students indicate that the equipment of the DIS functioned acceptably for the students, though interview and other questionnaire results indicate that some students were frustrated by the problems encountered with equipment performance. The indications from their remarks are that the difficulties mainly lay in program bugs or program features which made manipulation of the program difficult.

Average Rating	Statement
1.58	7. I could easily follow the organization of the lessons.
1.94	8. The lessons covered the right amount of material.
1.68	9. I would recommend these lessons to other soldiers.
1.84	10. I would take another course using this type of instruction.
1.61	11. The lesson content was clear and easy to follow.
2.31	12. I always knew where I was in the lessons and where I could go next.
1.68	13. The keypad was well marked and easy to use.
1.74	14. I would encourage my friends to take this training.
2.05	15. The content of the lessons was at the right level of difficulty.
1.84	16. Time passed quickly when I was using the new training system.
2.26	17. My interest in the HAWK System has increased because of these lessons.
2.89	18. The CAI Lessons were excellently done.
2.00	19. The simulation exercises were excellently done.
3.37	20. Breakdowns and mechanical problems occurred too frequently.
1.79	21. The visual displays were easy to see and understand.
2.22	22. The motion sequences helped my learning.
2.16	23. The simulation exercises really helped me improve my ability to troubleshoot problems with the HAWK integrated system check.

Figure 14

Summary of Attitudes Toward the System on Several Dimensions from Questionnaire Items

The interviews conducted during system evlauation did not identify new areas of information about the system and its acceptance as much as confirming and proportioning what was already known. One interesting finding of the interviews was that students tended to be divided on most issues and opinions expressed toward the system. Many students expressed a liking and appreciation for the demonstration lessons. Some students did not express as strong an appreciation and indicated that they felt the lessons were too long. Most students indicated that time passed quickly and that they did not experience fatigue. However, some students indicated that the brightness of the screen, the vividness of the colors, the jitter from the videodisc image and the conflict of the TV image with their glasses caused some problems of eye fatigue or eye strain. This was alleviated in part by moving the students back from the screen to view it from a further distance. The one-on-one trials conducted before the Phase II evaluation did indicate that the greater distance between the student and the TV monitor the better the result for the student in terms of eye fatigue and in terms of providing additional working space for the student.

Students tended to appreciate the "buddy system" that was used during the tests, where 2 students worked at one terminal. If the students were assigned with a buddy who worked at about the same pace and with the same learning style, the arrangement appeared to be beneficial, but some incompatabilities were encountered which caused students to remark negatively about the buddy system. Probably the best way to proceed is to allow students to choose their own buddies when pairing up for instructional purposes. Some students preferred the buddy system, indicating that they liked the conference mode of problem solution.

Most students expressed appreciation for the self-pacing and the ability to move at their own rate of speed during learning. Many students expressed the desire to take lessons which were available on the system but which were not assigned them. Some students appeared to be so wrapped up in the lessons that when break time came they found the break a nuisance rather than a benefit. In one case during the evaluation, students were taking instruction in demonstration lessons as the Space Shuttle landed. Though a television set was on in the instructional area, many students had to be reminded two or three times to watch the Space Shuttle land instead of watching their lessons. This interest in the lessons and many of the favorable comments about the lessons tempers the finding of other data that the lessons may have been boring to some students. Such a distribution of subjective feelings is expected in any learning environment. The data indicates that students who received no simulation were extremely positive toward the lessons. However, as the simulation was introduced to students, the lessons appeared too pale by comparison and became somewhat lower in the students' priorities. It was only at this point that students began to feel less positively toward the lessons. This confirms the high positive valence of most students toward the simulation, and we would expect a lower rating of the lessons in comparison with the simulation for those students.

Some students indicated that they felt the lessons contained too much reading. On the other hand several students indicated that they appreciated the reading and did not like audio presentations for instructional purposes. Several

students mentioned specifically their feeling that other mediated lessons compared poorly with the videodisc lessons on the DIS.

Several students indicated that they had no discomfort while using the system. Other findings, however, indicate that some students need to move back from the monitor due to potential eye strain problems.

Several students mentioned the usefulness of the instructors and the friendliness of the instructional atmosphere which they felt was more conducive to them achieving their instructional goals. These remarks tend to confirm the fact that the preparatory training given to the instructors was well received by the instructors and implemented, and that the students appreciated the attitude of the instructors.

Though several students expressed the interest in using real equipment, several others expressed the preference of the videodisc lessons and simulation over real equipment. The key to these opposite views probably lies in the natural feeling that real equipment instruction is likely to be more effective. Many intuitively hold that position, and it is logical. However, those students who expressed a preference for videodisc over demonstrations, may have been focusing on the fact that demonstrations using real equipment are often staged improperly or fail to produce the desired result when equipment malfunctions. Students in the classroom instruction group for this evaluation, with few exceptions, failed to get hands-on experience due to large group size and failed to see most of the demonstrations when the equipment was incapable due to local equipment and environmental restrictions. It is likely that the best course of action is to give students both videodisc simulator and real equipment practice but to ensure that the practice on the real equipment is in fact real, working practice. The best plan, of course, would be an extended study of skill development profiles using the simulator and using real equipment.

5.5.3.3 Phase III Results

The intent of Phase III was to try out lesson and simulation materials with students outside MOS 24E10. Though formal evaluation procedures were called for in the Evaluation Plan (i.e., observation logs, FITE tests), they were not implemented due to the heavy emphasis placed on the MOS 24E10 student evaluation. The instructional materials were used with several groups of non-24E10 students by the Ft. Bliss instructors, but no formal records were kept of those encounters, so no results are reported for those users.

6.0 Conclusion and Recommendations

The high degree of acceptance of the DIS installed at Ft. Bliss by both students and instructors and the high levels of performance of students who have used the system is encouraging.

The original system goals of cost reduction, distributed computing power, applicaton to a broad-spectrum of content and tasks, high visual and cognitive-

functional fidelity, and high productivity appear to have been met. These concepts embodied in the DIS have been demonstrated to be potent determiners of student achievement and potential factors for reduction of future training costs. These attainments have raised questions regarding other applications of the hardware and software technology used in the DIS both within and outside of the MOS 24E10.

We recommend four immediate areas in which training could be benefited for the I-HAWK Missile System and ways within each of those areas that the success of the current program can be used as a beginning point for further training program improvements.

The four areas of improvement are:

1. Expansion of Simulation Scope
2. Improvement in the Delivery System
3. Expanded Evaluation
4. Improved Training Base

Each of these areas is discussed in detail below.

Expanded Simulation Scope. The present capability of the simulation for improving student performance should be expanded from its present, relatively limited scope. The present simulation is capable of simulating problems occurring during the first step of the Four-parameter Auto Designate test of the HIPIR/LCHR ISC check. Although this is the most inclusive of the ISC checks covering many circuits, it is only one portion of the total ISC checks, all of which must be trained. In the Integrated Systems checks there are about 75 individual tests, all of which could be simulated with a suite of perhaps seven simulations. In addition to the seven basic integrated systems checks, there are also communications link-ups between the I-HAWK Missile System and higher order command posts for which simulation of circuits is appropriate. At present, training on those circuits is below desirable levels in terms of the amount of practice attainable by trainees due to expensive equipment hook-ups required. In addition, new equipment being introduced into the I-HAWK Battery in the coming years will present difficult training challenges to the DTD, and candidates for maintenance simulations include the Platoon Command Post (PCP), and the new high-powered illuminator radar (HIPIR) scheduled for introduction within the next year or two.

A second recommended area for expansion of the simulation capability is in the area of operator training. Individual and team training exercises are possible for procedures training using the system as it is presently configured. These may include simple procedural simulations or more complicated tactical simulations which we believe our system is capable of administering.

Improved Delivery System. The delivery system as presently constituted has been adequate in many respects for delivering instruction and simulation exercises to students. However, we recommend the following improvements to the delivery system aimed at improving the ease of system use for the volume of students which can be handled.

First, we recommend the implementation of the instruction and simulation programs on the WICAT 150 Computer rather than on the networked WICAT 100 DT as the system is presently configured. Individual 150 Model computers working as independent workstations without the need for being networked are capable of administering both instruction and simulation to students. The 150 comes housed in an attractive enclosure, and we feel it will be more easily maintained in the future years than the present 100 DT system installed at Ft. Bliss.

Second, we recommend the acquisition of additional terminals to be installed in the classroom at Ft. Bliss. The present complement of four terminals has served during the evaluation for both individual-student and two-student study mode. Although the evaluation found the two-student study mode to be successful and enjoyable to students, some students find this arrangement difficult to work in. At present, classes must be divided at the school. The installation of additional computers at the Ft. Bliss classroom would allow entire classes to be instructed at once without the "buddy" requirement. This would also allow the use of the computers by classes other than the MOS 24E10 classes. Evaluation results have shown that longer exposure to the system results in higher levels of student performance. Though this result is confined to the somewhat limited conditions of the evaluation, we feel that additional evaluations of the system will demonstrate that this is a consistent effect. The installation of additional terminals at the School will allow a greater amount of time to be utilized by each class and therefore by implication will improve the levels of student performance attainable at the School.

Third, we recommend the installation of a printer on the system and the provision of programs not presently available for report generation in printed form. At present, reports may be obtained by the Instructor or Course Manager at the storage station terminal screen, but printed reports are not possible, and no printer is attached to the storage station. The storage station computer or one of the workstations may be connected directly.

Expanded Evaluation. We feel that the evaluation to which the system has been subjected thus far is adequate to prove its effectiveness but does not give a full range of data on the total number of settings and applications in which the simulation and instruction may be effective. We recommend the following areas for extended evaluation activities.

First, we recommend that the extent of the simulation capability for training 24E10 students should be determined. The evaluation time constraints have allowed us to try out only two simulation problems with the students. The simulation is capable of generating literally thousands of unique problems. There are 10 to 15 major "types" or problems, each of them dealing with a different set of circuitry or slightly different troubleshooting steps. These should be evaluated. The question in an evaluation of this sort would be "How far can students to in their knowledge of troubleshooting and integrated systems circuitry using the DIS I-HAWK Simulation?" We believe the answer to this question is that the student can go quite far in mastering the integrated circuits, particularly when the simulation is used in tandem with

the troubleshooting exercise lessons as has been the case during the evaluation. We believe that students may be sent from the Ft. Bliss Air Defense School with much higher levels of proficiency than is currently the case and that this would require only a matter of three to five days of additional training over and above what is presently given the students. We believe that our evaluation showed that the 1 1/2 days that is currently allocated to students can certainly be made more productive than it has been.

We recommend that the evalution completed during this project for 24E10 MOS students be enlarged to include all students of MOS groups currently using the system at the school. This may include 24C and 24G students as well as 24R, Warrant Officer, and operator students. No formal data gathering took place for any of these student groups although the reports back from users at Ft. Bliss indicate that several groups profited from using the system.

In addition to additional MOS group evaluations, we would recommend the use of foreign military students in evaluations as well. Reports from Ft. Bliss indicate that non-U.S. students have used the system and have found that its low audio utilization and high textual orientation is congenial with their language abilities in English. We would recommend the evaluation of the system, both instruction and simulation, with non-U.S. soldiers and would further recommend that for those nationalities not capable of using the English version of the materials, non-English versions be prepared for the simulation. We believe this could be done in a relatively easy and inexpensive way, but that it may include the non-English development of some of the troubleshooting exercises and introductory lessons as well as the simulation.

We recommend the testing of the simulation and instruction in the field as a battery-attached refresher system. Several MOS groups are likely to benefit from the lessons, troubleshooting exercises, and simulation problems the system is capable of presenting. There is some indication in fact that problems presented by the simulator are more appropriate in their sophisticated form for more advanced and experienced students than are found at the 24E10 course. if this first impression is true, then we would be inclined to say that the effectiveness of the simulator in training I-HAWK maintenance personnel that has been observed this far is only the tip of a training iceberg and that the potential of this simulator in reducing training costs and improving maintainer performance is truly remarkable in its scope. We believe that an evaluation in the field would detect to what extent and with what groups the simulator could have some effect.

Finally, we recommend an evaluation of the factors of I-HAWK training using the DIS. Early in Phase II, a cost study was completed showing very large savings possible through simulations. A cost model unique to this project was used to forecast several levels of savings possible through the use of a simulator, depending on the simulator's ratio of transfer compared to real equipment. Data may be easily gathered at this point to show the real ratio for the DIS simulation, and that ratio could be used to project actually attainable training cost reductions attending simulator use.

Improved Training Base

The instructional materials and simulation for the DIS were prepared with a relatively minor commitment of time and energy to 24E10 job task analysis, training resource analysis and training methods analysis. We recommend that future developments for either instructional lessons or simulations be prefaced with appropriate analyses of the I-HAWK Training environment of the total group of MOS's involved in I-HAWK Training. Further, other Weapons Systems such as ROLAND, DIVAD, and PATRIOT have maintenance training requirements that can be met effectively with the WICAT DIS. We believe that a suite of analyses performed appropriately and with the appropriate tools which we believe were evolved during this initial development effort could show very great economies possible in I-HAWK maintenance training as well as providing an integrating view of those areas in which future simulation development should occur. We recommend the following types of analysis:

- Job Task Analysis. We recommend the conduct of a job task analysis for 24E10 and other MOS's trained at the Ft. Bliss school. If these analyses have already been performed, it may be well to validate those task analyses against actual field requirements as has been done in several Army communities during the past few years, including the Quartermaster School and more recently the Signal School. We believe that these analysis programs have the effect of improving the fit between school and field training requirements and remove from the school undue training loads for training which can be accomplished just as easily in the field. At the same time they insure that the students leaving the school are ready to assume those duties they will be assigned to upon reaching the field. Analytical evidence gathered during this project indicates to us that at present there is not a good fit between field expectations and graduate capabilities in the air defense community and particularly in the I-HAWK community for maintainers.

- Study of Current Training and Resources. During the course of the present contract, WICAT completed a study of the costs for I-HAWK training and found that great efficiencies are possible using the small amount of technology introduced by the DIS. We recommend a study of the current training resources and programs coupled with a cost calculation and cost tradeoff study like that conducted for this project to extend across multiple MOS's for the purpose of determining areas of training which are sensitive to the introduction of technology for the purpose of reducing costs.

- Training Systems Recommendations. We believe that resulting from the above analysis and cost study recommendations there should be a set of conclusions concerning I-HAWK Training and possible economies which are attainable through the use of increased levels of technology in the Air Defense School curriculum. These recommendations could be used as a foundation on which to build an improved curriculum and general curriculum practices for emerging weapon systems such as the Patriot.

APPENDIX A

Early
Description of
The Distributed Instructional System

THE DISTRIBUTED INSTRUCTIONAL SYSTEM FOR I-HAWK TRAINING

The Distributed Instructional System (DIS) is a powerful computer-based system designed for Computer-Assisted Instruction (CAI), Computer-Managed Instruction (CMI), and two- and three- dimensional training simulation. The system also has several other uses in management of business and training information and word processing which are not covered in this description.

The System

The structure of the DIS system is shown in Figure 1. The system's computing power is distributed among individual, interactive terminals called "workstations." Each workstation has its own powerful microprocessor computer, a keyboard, and display capability, and each is connected to a central "storage station." The storage station consists of a computer like that in the workstations and a 20-45 megabyte hard disc memory.

Up to 100 workstations can be connected to a storage station through RS-232 coaxial cable or fiber optic links, which permit extremely rapid transmission of large bodies of data like those used in simulation to individual workstations. In the distributed instructional system concept the power for computing is located at the individual workstation and not at the central storage station. Unlike monolithic central computer systems, there is no requirement for time sharing because of the large workstation computer power and memory and because of the rapid data transfer capability from the storage station to the workstation.

The workstation and storage station controller computers are based on the new Motorola MG68000 microprocessor chip, which will be augmented by 256K bytes of RAM memory. The MG68000 chip is a powerful microprocessor, capable of executing two million instructions per second, which gives it roughly the power of a DEC 11/70 minicomputer.

The storage station and its attached workstations constitute a system which can stand alone. However, to facilitate the update of organizational data bases and record maintenance, the storage station may be hooked through conventional computer linkages to virtually any host computer. This link can be made at low computer usage periods and at intervals specified by the user. The link is not necessary for the system to function. A secondary communication and update capability for programs and data bases is provided through a cartridge tape drive capability at the storage station.

The Economy of Distribution

The distribution of computering power to individual workstations is a powerful concept because it eliminates the inefficiencies of time sharing. It also allows for a computer-based instructional system to be built without the

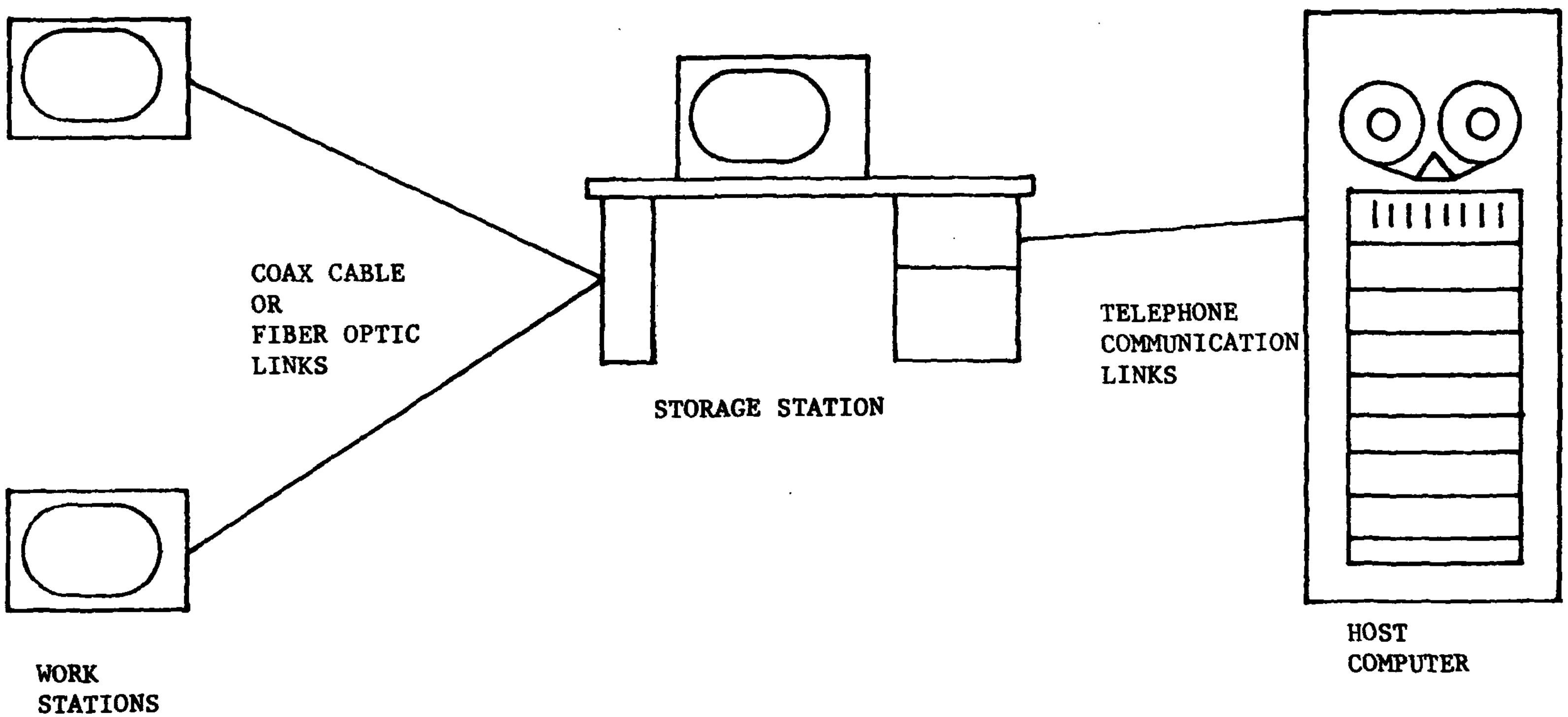


Figure 1
Structure of the WICAT Distributed
Instructional System

initial expense of a large central computer and its software. Each workstation can function independently and is self-sufficient, since the first workstation purchase is in a storage station configuration. Thus, a computer-based system may consist of one terminal or several terminals with the only incremental expense being the number of terminals purchased.

Training Applications

Although the DIS is a computer system of multiple uses, the system has been optimized for training. The CAI, CMI, and simulation capabilities of the system allow it to save training costs. The DIS workstation has been developed to include the latest random access videodisc player technology, which is used mainly in simulations, but which is also highly useful in certain CAI applications.

The DIS is powerful enough to execute the full range of instruction techniques. System use by instructors and writers has been facilitated by the creation of the Courseware Design System (CDS). CDS is a high-level instructional material authoring language which allows the instructor to communicate with the computer in natural language (rather than computer code) to create instructional sequences and tests.

Computer-managed instruction routines are capable of tracking student instructional parameters and progress. They are also capable of maintaining data on system use and instructional effectiveness. These are extremely useful tools when precise knowledge of student capability and progress are desired on a continual basis. The CMI capability is also desirable for prescribing instructional treatments for student remediation. CMI acts to increase the efficiency of the training system.

The two-dimensional and three-dimensional simulation capabilities of the DIS are among its most important training features because of their tremendous potential impact on the overall cost of training.

For training in the use of complex and expensive equipment, or when the skills begin trained are dangerous, simulation is capable of saving large amounts of student "hands-on" time. DIS simulations are capable of paying for themselves through savings in the use of expensive or scarce equipment. Much of the equipment can then be made free for operational use rather than for training.

Both two-dimensional and three-dimensional simulation capabilities are possible using the distributed instructional system. For two-dimensional simulations, student interactions with the simulation program take place through the CRT display using keyboard or light pen. For three-dimensional simulation use, the DIS is readily interfaced with new or existing training equipment. A wide variety of simulations are possible using both two- and three-dimensional simulations, and a growing body of training developers have realized the potential power of such simulations and the attendant cost savings.

Training for the I-HAWK Missile System

Under a contract presently being carried out for the U.S. Defense Advanced Research Projects Agency (DARPA), computer-assisted instruction and two-

dimensional simulations are being created for training of U.S. Army students in the maintenance of the I-HAWK missile system.

The scope of this training includes the isolation and correction of malfunctions occurring during the Integrated System Checks. The instruction being created covers the normal function of the I-HAWK system during the checks and the use of manuals, charts and diagrams, consulted during fault isolation.

The topic of instruction is the function of the system during the Four-Parameter ADP Designate portion of the HIPIR/LCHR check and the use of system maintenance manuals. This instruction consists of six CAI lessons on the flow of signals during the check and the use of system manuals. During the writing of this instruction methods have been developed for efficiently authoring instruction of this type. Therefore, extension of this type of instruction to to other ISC checks will be relatively inexpensive.

Simulation

A two-dimensional simulation is also under development. It includes simulation of problems occurring during the Four-Parameter ADP Designate test. The simulation will be capable of creating a variety of problems for the student, graded over the easy-to-hard range. The simulation will be capable of selecting problems at the appropriate level of difficulty for the student. During simulation problems, the student will interact directly with the display, making tests, observing system conditions, replacing components, and performing the full range of troubleshooting procedures as if interacting with a real system. At the end of a troubleshooting problem, the simulation will determine the amount of time and money spent by the student in searching for problems and replacing faulty parts.

System Cost

Once of the main principles guiding the design of the DIS has been cost minimization. It is believed that the DIS provides the most cost-effective means of providing computer-assisted instruction and simulation for most applications. Since the system is constructed one terminal at a time, the only incremental costs as the system expands are the costs of individual terminals. The system user does not pay high initial costs for the acquisition of costly computer systems, environments, and operators.

The DIS system does not incur expenses for special environments. No air conditioning is required, and there are no special power requirements. Since the DIS comes housed in its own console, there is no additional charge for desks or carrels. Headphones are provided with each DIS terminal to eliminate noise interference between terminals.

Conclusion

This summary is a sampling of the features possible using the DIS. The system's power and ability to be used in different configurations allow it to handle several training and management problems simultaneously. The uses of the system for training, and especially for HAWK training, use the system's power to increase the overall quality of instruction while reducing its costs.

APPENDIX B

System Operating Procedures

SYSTEM OPERATING PROCEDURES

This section provides procedures for operating the I-HAWK DIS. The system has been designed to operate easily and require no programming ability.

These procedures assume a networked system properly connected, with a monitor attached to the central storage station. If any procedures fail to work, do not attempt to fix the system yourself. Call the system operator to help.

The procedures outlined are:

SYSTEM STARTUP

System startup has been automated to the point where it consists mainly of powering up individual system components in a given order. Follow this procedure for system startup:

1. Turn on each workstation TV monitor by pulling the on-off knob out. The knob is located below and to the left of the channel selector. Turn the volume fully counterclockwise using the same knob.

2. Turn on each workstation computer.

   (a) Insure that the power connector is plugged into a wall socket, that the computer is plugged into the power connector, and that the power connector is turned on. When the connector is on, the orange lamp will glow on the connector.

   (b) Push the top half of the computer's power rocker switch to ON. The rocker switch is located at the upper left corner of the rear computer panel as you face the computer. As you turn on the computer you will hear a fan inside begin to turn.

3. Turn on each workstation videodisc player.

   (a) Insure a videodisc is loaded in each machine.

   (b) Insure that the player cover is closed tightly.

   (c) Press the key labelled POWER until it catches in the ON position.

   (d) Press the key labelled PLAY and watch to insure that the disc moves

under the play area.

(e) After counting to 15 slowly, press the STOP key until the red lamp above the key remains on.

4. Turn on the storage station monitor using the rocker switch at the bottom right rear of the monitor case. You will hear a "beep" sound when it receives power. Wait until the square white cursor appears on the screen before proceeding.

5. Turn on the storage station using the rocker switch on the front left panel of the storage station. The red light on the front panel will illuminate, and the storage station fan will begin to hum. Writing will begin to appear on the monitor screen.

At this point, wait until the TV monitor at each of the workstations presents a text message. This may take up to ten minutes.

SYSTEM TURNOFF

Turn off system components only after all workstations are logged off to avoid loss of student data.

Turn off system components in this order:

1. Storage station computer.

2. Storage station monitor.

3. Workstation videodisc player.

   (a) Press the key marked REJECT and wait for the disc to come to a stop before proceeding.

   (b) Press the key marked POWER until it comes out all the way and the red lamp above it extinguishes.

4. Workstation computer.

5. Workstation TV monitor.

WORKSTATION REBOOT

When a workstation hangs, it may be necessary to reboot. Use this procedure for rebooting:

1. Press the flat, flush-mounted computer reset switch and release it. it is placed to the right of the workstation computer's power switch as you face the computer.

2. Wait up to five minutes. The text message should appear on the workstation TV monitor.

STORAGE STATION REBOOT

When all workstations are hung and it appears to be a storage station problem, you may have to reboot. Use this procedure for rebooting:

1. Press the flat, flush mounted computer reset switch and release it. It is mounted beside the computer power rocker switch.

2. Wait until the storage station asks you for the date. Press RETURN on the storage station monitor keyboard until you see a series of ">" symbols in a vertical line on the screen.

3. Reboot all workstations.

DISC SIDE CHANGE

When the workstation TV monitor displays a message requesting a change of the videodisc to a new side, follow this procedure:

1. Press the key marked REJECT and wait until the disc comes to a full stop.

2. Press the key marked COVER RELEASE. The player lid should pop open slightly.

3. Lift the player lid fully open.

4. On the central disc spindle, grasp the spindle at the indented spot half-way down the shaft. Pull up until the foot holding the disc in place lifts and you hear a click.

5. Grasp the disc at its left edge and lift it from the spindle carefully.

6. Turn the disc over and replace it on the spindle with the left side higher than the right by about 1 1/2 inches until the disc lays flat on the spindle bottom.

7. Pinch the top of the spindle as marked until the disc holder foot clicks into place.

8. Close the player cover until it clicks securely shut.

9. Press the key marked PLAY. Watch until the disc moves in.

10. Press the key marked STOP until the red lamp above it remains lit.

11. Press ENTER on the student's keypad. A video picture should appear after a very short time.

STUDENT REGISTRATION/DELETION/CHANGE

To register or delete a student or modify student registration data, follow this procedure:

1. Insure that the storage station monitor is connected to the storage station computer.

2. Press RETURN several times. Several ">" symbols should appear.

3. Type /TCPROG and press RETURN. A menu should appear.

4. Select "Registration" from the menu by following the instructions on the screen.

From this point, full instructions are provided at the monitor by the program. Follow those instructions. When you are finished, be sure to "QUIT" the program from the menu.

REPORT VIEWING

To view system reports, follow this procedure:

1. Insure that the storage station monitor is connected to the storage station computer.

2. Press RETURN several times. Several ">" symbols should appear.

3. Type /TCPROG and press RETURN. A menu should appear.

4. Select "Reports" from the menu by following the instructions on the screen.

From this point, full instructions are provided at the monitor by the program. Follow those instructions. When you are finished, be sure to "QUIT" the program from the menu.

EXAM MAINTENANCE

The Exam Maintenance program is designed to allow the instructor to control the content of exams. There are two areas involved in exam maintenance:

1. The controlling factors in the exam:

   - The number of questions to be asked
   - Percentage correct to pass
   - The exam passcode (entered by the instructor)
   - The maximum time (in minutes) allowed for the student to take the exam

2. Maintaining question content:

   - Adding questions
   - Deleting questions
   - Changing questions
   - Viewing questions for review purposes

The Exam Maintenance routine is accessed at a workstation by an instructor logged-on under either an instructor or a manager user number.

At the System Menu, NEXT is pressed, which brings up page 2 of the menu. "Exam Maintenance" should be selected at this point, which calls the maintenance program.

Upon entering the program, the instructor sees the following menu:

1. View/change exam size or criteria

2. Change exam question

3. Add exam question

4. Delete exam question

5. View exam question

6. Quit

Option one (1) allows the instructor to change or set the:

- Number of questions to be asked: A maximum of 50 questions may be given to the student because the maximum number of questions in the pool is 50. The minimum number allowed is 1.

- Percentage correct to pass: This field will be expecting a value between 1 and 100. No decimal points will be allowed and no percent signs (%) will be necessary. A "50" typed in will mean 50%, a "75" signs (%) will be necessary. A "50" typed in will mean 50%, a "75" will mean 75%. This percentage is the percentage of those questions given to the student that must be answered correctly in order to pass the exam.

- Exam passcode: Before the student can take an exam, the instructor must enter a 4-digit passcode. (No alphabetic characters are allowed.) Each exam may have a different passcode, or they may all be the same.

- Maximum time: This is the maximum time, in minutes, the student will be allowed to spend on an exam. It must be a value greater than zero. At the end of this time the exam will be terminated and scored. If the student has enough correct answers to pass, even though he ran out of time, he will still pass. If he does NOT have enough correct answers by this time, he will NOT pass the exam.

Option one also displays the number of questions currently existing in the lesson. Instructions on the screen direct the instructor how to respond.

Maintaining questions is done using options 2-5 of this main menu:

1. View/change exam size or criterion

2. Change exam question

3. Add exam question

4. Delete exam question

5. View exam question

6. Quit

Upon choosing to DELETE a question, the instructor is shown the text of the question and must confirm the delete with a "Y" (Yes) or "N" (No).

When VIEWing a question, the instructor is shown what the question currently looks like, but the question cannot be changed, added to, or deleted in this mode.

To CHANGE or ADD a question, the instructor follows the same process, the only difference being that a question to be added has no information in it, while a question to be changed has the existing information in it.

For adding and changing lessons, after the selection of the lesson number and question number the instructor is asked to press RETURN and then add or change the text of the question. On pressing RETURN he either sees a blank screen (if adding) or the text of the question (if changing). In the top left corner of the screen will be a cursor (_) that signifies where he will enter text. He may then move the marker anywhere on the screen and type the question just as he wishes the user to see it. Following are certain commands that may be used while editing:

^A - Move to the front of the line.*
^B - Delete previous word.
^S - Delete current word.
^D - Delete to end of the line from "_".
^F - Move to beginning of next word.
^G - Move to end of the line.
^O - Move to the beginning of the next line.
^R - Move to the beginning of the previous word on the same line.
^T - Move to the top of the screen.
^U - Delete from "_" to the front of the line.
^V - Delete the current character.

*The "^"symbol signifies the control key (labelled CTRL on the keyboard). Whenever the symbol is encountered, it means to strike the following key while HOLDING DOWN the control key.

The arrow keys and delete (DEL) key are also functional.

APPENDIX C

System Maintenance Procedures

SYSTEM MAINTENANCE PROCEDURES

There are no system maintenance procedures advised to be performed by system users. The system equipment has been designed or selected for low maintenance requirements. Dust on the fan cover opening may be removed with a vacuum periodically to improve air flow. Floppy disk drive heads and tape drive heads should <u>not</u> be serviced by users, even for cleaning purposes.

APPENDIX D

Evaluation and Implementation
Plan for the DIS --
Task 2 Evaluation

EVALUATION AND IMPLEMENTATION PLAN
FOR THE DIS - TASK 2 EVALUATION

I. Introduction

The purpose of this plan is to specify the tasks and schedules associated with the evaluation of the equipment and software system prepared for the use of the U.S. Army Air Defense School (USAADS) for the training of HAWK missile maintenance personnel.

II. Systems Operational Evaluation

A. Objective: The objective of this evaluation is to assess the reliability of DIS hardware and software.

B. Schedule: The evaluation will take place during a one-week period between 15 July and 15 September 1981. Exact dates will depend upon the availability of Army personnel.

C. Method: The evaluation consists of four users exercising the system for eight hours per day using the networked DIS software and at least one instructional lesson.

D. Questions: Questions to be answered during this evaluation include:

Hardware

- Do WICAT systems diagnostics function reliably during workstation power-up?
- Does the storage station successfully boot from the tape drive?
- Does the storage station dump data to the tape and successfully retrieve it?

Software

- Does the instructional software perform without failure through a specified test period?
- Does the system software perform without failure through a specified test period?
- Does the system software survive specified rigor tests?
  - — Simultaneous request tests
  - — Volume request tests
  - — Simultaneous station use tests
  - — Station casualty tests

In the event that 24E HAWK students are used as testers, additional evaluation data may be gathered on the following instruction-related questions.

- Are the formats and patterns of interaction for the lesson easy to use, appropriate to the audience?
- Is the content level of the lesson appropriate to the audience?
- Are students able to learn and achieve mastery from the instruction?

E. Resources: During the evaluation week, four Army testers will be required.

Free access to the testing area before and after testing hours will be necessary to allow adjustment and programs.

Two WICAT personnel will be present during the evaluation period to provide technical support for the effort, observe the tests, and gather evaluation data. The USAADS Evaluation Coordinator will also be required to interface with tester personnel, manage facilities, and provide direction for USAADS during the evaluation. The coordinator should be present during the evaluation to assure USAADS that the data is being properly gathered and that tests are being properly run.

F. Revisions: Revisions to hardware and system software which are required to bring the system operations to within the operating criteria will be made during the evaluation period. Incidental data on instruction will be applied to revision of the CAI lessons.

APPENDIX E

Test Problem Presentation

The speech used for presentation of the problem to test subjects is given below.

The Army tester would say:

> "This will be a test of your troubleshooting ability. I will act as a BCC connected in a functioning I-HAWK system. I will present to you a problem symptom found while running the 4-Parameter Auto Designate Test of the High Power/Launcher check. You can request information from me about switch settings, indications, tests, or measurements, and I will respond by giving you any information normally available to a troubleshooter with tools. You must isolate the fault to a component, replace the component, and re-run the 4-Parameter test successfully. This will be a timed test. Here is the symptom. While running the test, the test goes all the way to completion, but the SIGNAL STRENGTH meter on the FC panel fails to show

APPENDIX F

Sample Student Attitudinal Questionnaire

HAWK VIDEODISC TRAINING QUESTIONNAIRE

Directions: This questionnaire asks for your comments, ratings and personal reactions to the HAWK videodisc training system and lessons. Your honest comments and reactions will help us to revise and improve the HAWK training system for future groups of soldiers. Your responses will be kept anonymous and confidential.

I. Biographical Information

1. _____ Instructor _____ Student

2. Current MOS _______

3. RANK ________

4. Sex: ____M ____F

5. Age: ______

6. Years in Armed Services ________

7. Which of the following types of instruction have you had experience with and which do you like best? Place a check ( ) in the first column for all types of instruction you have experienced. Then rank each of your responses in order of your preference. (1=first, 2=second, 3=third, etc.)

	Exper.	Rank	
1.	_____	_____	computers
2.	_____	_____	videodisc
3.	_____	_____	intelligent videodisc
4.	_____	_____	small group discussion
5.	_____	_____	TV
6.	_____	_____	films
7.	_____	_____	individual study
8.	_____	_____	simulation
9.	_____	_____	classroom lecture
10.	_____	_____	others (Specify)_____________________________

II. General Questions

1. What did you particularly <u>like</u> about the HAWK videodisc training system and lessons?

CAI Lessons	Simulation
1.	1.
2.	2.
3.	3.
4.	4.

2. What did you dislike about the HAWK videodisc training system and lessons?

CAI Lessons	Simulation
1.	1.
2.	2.
3.	3.
4.	4.

3. What improvements would you recommend for the HAWK videodisc training system and lessons?

CAI Lessons	Simulation
1.	1.
2.	2.
3.	3.
4.	4.

4. What are your personal reactions to the keypad for entering responses?

5. Are there any materials which should be added to or eliminated from the videodisc training?

<u>Materials to be Added</u> | <u>Materials to be Eliminated</u>

6. Which lessons or parts of the CAI instruction and Simulation training were most beneficial?

<u>CAI Instruction</u> | <u>Simulation</u>

For questions 7-24 circle your response using the scale on the right.

	1	2	3	4	5
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7. I could easily follow the organization and sequence of the lessons.	1	2	3	4	5
8. The lessons covered the right amount of material.	1	2	3	4	5
9. I would recommend these lessons to other soldiers.	1	2	3	4	5
10. I would take another course using this type of instruction.	1	2	3	4	5

11.	The lesson content was clear and easy to follow.	1	2	3	4	5
12.	I always knew where I was in the lessons and where I could go next.	1	2	3	4	5
13.	The keypad was well marked and easy to use.	1	2	3	4	5
14.	I would encourage my friends to take this training.	1	2	3	4	5
15.	The content of the lessons was at the right level of difficulty.	1	2	3	4	5
16.	Time passed quickly when I was using the new training system.	1	2	3	4	5
17.	My interest in the HAWK system has increased because of these lessons.	1	2	3	4	5
18.	The CAI lessons were excellently done.	1	2	3	4	5
19.	The simulation exercises were excellently done.	1	2	3	4	5
20.	Breakdowns and mechanical problems occurred too frequently.	1	2	3	4	5
21.	The visual displays were easy to see and understand.	1	2	3	4	5
22.	The motion sequences helped my learning.	1	2	3	4	5
23.	The simulation exercises really helped me improve my ability to troubleshoot problems with the HAWK integrated system check.	1	2	3	4	5

24. How was the HAWK videodisc training different from other learning and training experiences you have had?

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